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Factors of Organic Evolution.

II.—Natural and Intra-organismal Selection.

By W. P. PYCRAFT.

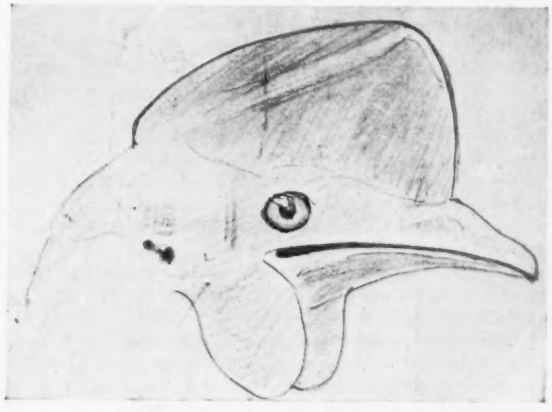
THOUGH the Doctrine of Evolution now passes unchallenged there is by no means the same unanimity in regard to the machinery, or what Cope more happily termed the "Factors" of Evolution. The "factors," according to Cope, were dynamistic, and when we come to traverse the ground he covered in his search for evidence in support of his views we become at the same time almost persuaded of the reasonableness thereof. A little consideration, however, will, I venture to think, convince those who have fallen under this spell of its inherent weakness. I do not, however, propose to analyse this, or any other of the many theories that have been advanced during recent years by way of improving on Darwin's great theory of Natural Selection, but make special mention of this particular theory because it was concerned, very largely, with just the kind of evidence which was discussed in my last essay in the November issue of "KNOWLEDGE," and is to form the subject matter of the present.

In the November issue just referred to it may be remembered the phenomena of "Homoplasy" were discussed; that is to say, the action of the environment on living organisms, as a whole, was considered, and it was shown that there is an apparently intimate relation between the external form of the body and the physical environment thereof. Hence Homoplasy. But a study of Comparative Anatomy brings to light a host of characters which seem to have no relation whatever to external influences, and many illustrations thereof are to be found collected under the head of "Fortuitous or 'Definite' Variations." Others, however, appear to be of a more orderly character; they seem to display a certain regular sequence, or progressive development, and these also, in a very great number of cases, are apparently uninfluenced by the external or physical environment.

Such seem to justify us in assuming that all variations, whether "definite" or "indefinite," "continuous" or "discontinuous," are blastogenic in origin; that is to say, arise from so many permutations and combinations of the elements of the germ plasm, which, from its very nature, cannot be stable, but that while some escape the sumptuary laws of Natural Selection others become subjected to its most rigorous conditions; that, in other words, variations, in all directions, are free to arise, must arise, and that they proceed to work out their own salvation; they are free to pursue their own course unless, and until, checked by Natural Selection. On this explanation the objection as to the inutility of incipient organs is disposed of, the objection as to the value of "minimal increments" in the struggle for existence is overcome. They *have* no value until large enough to influence the fate of the organism one way or another.

Cope's factors, "Physiogenesis" and "Kinetogenesis"—the influences of physico-chemical (molecular) and mechanical (molar) forces—appear alluring only until we regard the problem from this point of view. The environment does not mould the organism; the organism fits itself to the environment. The action of the environment on the somatoplasm is not transmitted to the germ-plasm; the former is thrown, so to speak, by the latter into the world with all the defects of its qualities, and the adjustment of the balance of these is all that the environment can effect, directly or indirectly.

The kind of evidence on which Cope based his theory of Kinetogenesis is to form the principal theme of the present article, but—and to this we shall return—the phenomena should really be considered in the light of



Head of the adult *Casuarius uniappendularis* showing the final development of the casque.

Roux's "struggle between the parts"—as an intra-organismal warfare.

Let us begin by citing the remarkable modification of the skull in the whale-bone whales, wherein the supra-occipital is enormously developed, extending forwards, in its most extreme development, to form almost the entire roof of the cranium and displacing thereby the parietals and frontals. The former during fœtal life meet in the middle line above, and are overlaid by the supraoccipital; later this covered portion becomes absorbed. In the Cassowaries the roof of the skull is surmounted by a huge bony casque encased in horn. This casque, as may be seen in the nestling, is made up of several elements—a median portion arising from the roof of the mesethmoid, and two lateral pieces formed by the inflation of the proximal ends of the nasals, and two basal pieces formed by the inflation of the juxtaposed moieties of the frontals. All these contribute to

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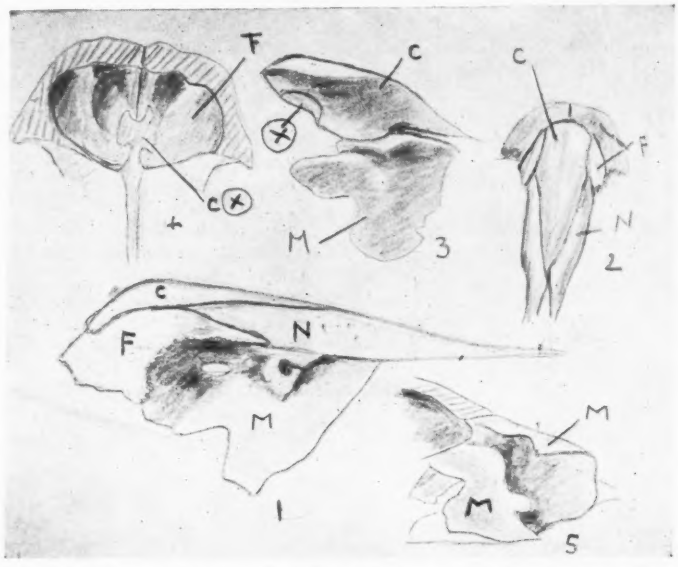
form a tumid swelling on the skull, but as development proceeds the mass rises to form the large homogeneous casque of cancellated tissue seen in the fully adult bird. With the vertical rise there is also a backward extension on to the frontals; and here, just as in the case of the parietals of the whales, the overlapped bones become absorbed, with the result that the superficial casque, by its hinder overlapping moiety, comes to force its way, as it were, into the warp and woof of the skull, inasmuch as for a small space it actually contributes to form the covering of the brain. This, in itself, is a remarkable fact, but what agency has been at work to extend this excess of pneumatic bony tissue from the central mass to the neighbouring bones—frontals and nasals? What is the origin of the casque itself? Was it originally merely an upward expansion, or inflation, of the dorsal surface of the mesethmoid, or was it a purely dermal nodule of bone resting upon the mesethmoid, and fulfilling a quite different purpose to its present ornamental rôle? The casque of the Cassowary is unique, for the superficially similar casques of the Hornbills have a different history. The case of the whale's skull, on the other hand, is one which shows a series of progressive developmental evolutionary stages in different species of whales. The sternum of the whales shows, on the other hand, a no less striking series of devolutions—of the gradual degeneracy of this region. The sternum in *Berardius* displays an undoubtedly primitive condition, being composed of five quadrangular segments showing evident traces of a paired arrangement. Starting from this we find a wonderful series of gradations of degeneration, till, in *Balæna* and *Balænoptera*, nothing more than a single shield-shaped plate remains. And the same story of degeneration is told by the teeth, for, among the toothed whales, we can start with jaws fully armed and trace the gradual reduction of the teeth till toothlessness is reached.



The development of the casque of the Cassowary, as shown in the skull of the immature bird.

1. Side view of a portion of the skull showing the mesethmoid (M), nasals (N), frontals F, and the median portion of the casque (C).
2. Dorsal aspect of the same.
3. Mesethmoid and median portion of casque dissected out.
4. Interior of skull showing the hinder portion of the casque marked × in fig. 3, which, by absorption of the frontals has forced its way into the skull.
5. The mesethmoid of a young Emu to compare with that shown in fig. 3.

Before proceeding further let it be noted that evidence has been given of two distinct aspects of evolution and devolution—(1) wherein one or other of these phenomena is displayed in the life-history of the individual, and (2) wherein the same story is to be pieced together in the history of a number of nearly related species. And to this point we shall return. Attention is drawn to the matter here to prepare the way for what follows.

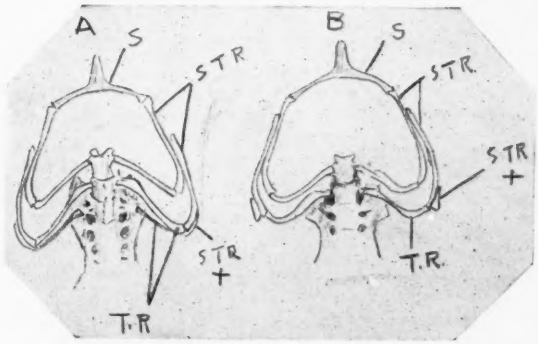
Very well, I now propose to cite one or two cases from among the birds.

The vertebral column is undergoing a gradual process of reduction, and simultaneously therewith we have a like reduction in the number of ribs attached to the sternum; giving an apparent increase in the number of cervical vertebræ, for it has been the custom to regard all the vertebræ in front of the last attached by ribs to the sternum as "cervical." This is a most misleading practice, since more or fewer of the hindmost of this so-called cervical series bear free ribs, some, indeed, retaining their uncinate processes, and even traces of the sternal segments of the ribs, showing that, until "recently," these ribs were attached to the sternum, and hence belong to the "thoracic" series, or to the series commonly but mistakenly called "dorsal."

The ribs, however, are undergoing a similar and still more interesting process of reduction at the hinder end of the trunk. Here they remind one, in the manner of their going, of the Cheshire cat in "Alice in Wonderland," which gradually vanished till nothing but the smile was left, and finally this also disappeared! And this because, unlike the ribs of the anterior thoracic vertebræ, they do not gradually decrease from this distal end upwards till nothing but the head is left, but begin to wane at *both* ends, though the distal—sternal—segments are the first to show decided evidence of the change. This is indicated by the loss of attachment with the sternum and the formation of a new articular surface near the articular end of the rib next in front. Where two or three ribs have lost their sternal attachment each rib is attached to its fellow next in front, but in each case the retreating rib articulates higher and higher up the rib next in front of it. At last signs of decay in the upper end of the rib sets in, and finally the proximal articular end becomes "absorbed." Then the rib is reduced to the condition of a semicircular rod attached at each end to the rib next in front, and finally, all that is left of the hindmost is a minute spicule of bone attached to the lower end of the dorsal segment of the neighbouring rib! The curious difference in the fashion of the downward career of the anterior and posterior thoracic ribs is possibly to be ascribed to the accident of position. Here we get a process of evolution or devolution, but what starts this? The steps are infinitely slow, and the resultant changes can, so far as we can see, bear no serious relation to the problem of the struggle for existence. When the attachment to the sternum is lost what agencies are at work in the formation of the new articular surfaces? If, as some contend, the reduction is effected to conserve economy, why is energy wasted in the formation of new articular surfaces?

The case of the sternum is somewhat different, for while in the matter of the reduction of the ribs no tangible cause can be traced, in the sternum degeneration can be certainly ascribed to degeneration in the powers of flight which, in turn, seem to be intimately related to environmental conditions. Flightless birds can exist only where the need for flight is absent—a congenial climate, abundance of food to be obtained without the use of wings, and freedom from enemies.

In all the vertebrates above the fishes the vertebræ supporting the hip-girdle have undergone a more or less marked transformation. This is very slight in the Amphibia and Reptiles, because the weight of the body is not entirely borne by the limbs, but in the birds and mammals more or fewer vertebræ have undergone profound changes of shape in the direction of increased strength to withstand the strain put upon them in supporting the trunk. The most striking of such changes are manifested in the fusion of those vertebræ embraced by the upward limbs of the girdle, and this fusion apparently results directly from their inability to move, one on the other, owing to the grip of the girdle. But



Semi-diagrammatic figure showing the process of reduction of the hinder ribs.

In A one pair of ribs is attached to the sternum by the sternal segment of the rib. The next pair fail to reach the sternum; so also does the succeeding pair, the thoracic segment of which is beginning to dwindle: the sternal segment is now exceedingly reduced. In B the thoracic segment has vanished leaving only a vestige of the sternal segment marked STR+. TR = Thoracic rib. S = Sternum seen in section.

the whales have no vertebræ which can be distinguished, skeletally, as sacral. Yet the whales had hind-limbs, as the vestiges thereof testify. Are we to assume, then, that the ancestral whales betook themselves to an aquatic life before "sacral" vertebræ had come into being, or that a "sacrum" or fusion of pelvis-supporting bones was formed and that the some-time fused vertebræ have again become free and re-assumed their original likeness to those immediately in front and behind—lumbar and caudal vertebræ? Having regard to the fact that in the embryonic condition the peculiar characters of the sacral vertebræ are wanting, and bearing in mind the peculiar requirements of the vertebral column in the whales, it is possible that the present-day condition of the column is due to an arrested development, to a suppression of the normal course of growth which would end in the formation of a "sacrum." But what agency applies the brake? Flightlessness among the birds has involved the wing, shoulder-girdle, and sternum in one uniform ruin, save only in the case of the Penguin. And this because, in all save the Penguin, the wings were of no further use; in the Penguin the progress of degeneration was checked because the wings served as paddles. Perchance, however, these wings should be classed not as brands saved from the burning, as organs saved from destruction, but as organs transformed by new use while still in vigorous condition. The degeneration now apparent, such as the loss of the pollex, may have taken place *pari passu* with the evolution of the paddle, the pollex being useless. The great length of the third digit serves to lend weight to this view, for this elongation is a primitive condition. The sequence of events, however, in the history of the hind-limb of the whales, since it ceased to be useful, cannot be measured by this comparison. The degeneration of the limb, of course, offers no difficulties, but this is not true of the absence of the sacrum, or more correctly, "synsacrum."

I have purposely brought together here a number of cases of very different nature. Some of these illustrate the evolution of characters which seem to have no apparent connection with the "struggle for existence"; others, on the other hand, are intimately related thereto. According to some these differ not in kind, but in degree. Yet I venture to think this is not the case. That, in short, living animals represent the sum of a double set of conditions—the struggle for existence between the parts of the organism, and the struggle for existence between the organism and its external environment. The organism, as a whole, is the record of this internal and external warfare; thus vestigeal organs do not necessarily represent the results either of present or past external conditions. They may be the outcome of internal conflicts, and the same applies to dominant characters. This is not a new idea, but it is one commonly lost sight of, and especially by those who study external characters only.

(*To be continued.*)

Stability of European Climate.

FOR many years it was asserted that the east coast of Greenland had formerly enjoyed a mild climate, which favoured the growth of vegetation and gave rise to the name Greenland. The historical researches of Rink and Von Maurer, however, have proved that the decay of the posts established by the Norwegians in olden times was caused by the introduction of a contagious disease and by the adoption, by the Norwegian Government, of an unwise economic policy, which provoked hostile attacks by the Eskimos. Equally erroneous statements have been made in regard to Iceland. In the British Isles, the cultivation of wheat formerly extended much farther north than it does at present, simply because it was then, in the absence of foreign competition, more profitable that it is now. Yet it has been very difficult to gain acceptance for this elementary truth; the popular belief in a change of season or climate for a long time prevailed over all evidence. In Belgium and other countries, also, agriculture has been radically transformed by the operation of economic laws, improved methods of culture, and a more intelligent choice of crops. In the Middle Ages and until the fifteenth century the vine was cultivated in Bavaria and in other parts of Germany from which it has now almost entirely disappeared, but its disappearance is not due to climatic changes. The wine produced in these districts was generally of inferior quality and, with the growing refinement of taste, it was gradually supplanted by foreign wines and good native beer.

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Pathology in Handwriting.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

IN a previous paper ("KNOWLEDGE," 1908, 255) the form of handwriting was shown to be an inherited trait, modified more or less permanently by training and other external influences, and varying temporarily under the stress of emotion.

The extent to which such emotional disturbance of writing will occur in the case of a normal healthy individual will naturally depend upon his sensitiveness to emotional impressions and the degree of control he can put upon his writing movements.

It is rarely, however, that words written, for example, in moments of excessive anger or overwhelming depression will not, on comparison with the normal writing, show some indication of the state of the mind.

One of the most interesting historical instances of this tendency of handwriting to vary with the mood of the writer is to be seen in the signatures of Napoleon at various periods of his career. Several of these, written on occasions calling forth widely differing emotions, are here reproduced, and it is not difficult to discern in some of them the effects of emotional influence. Very striking, for instance, is the difference between the orderly signature written after the victory at Austerlitz and the blotted scrawl dashed off after the defeat at Leipzic. Nor will it escape notice that all the signatures made at times of depression or failure have a downward slant, whereas that of the victor of Austerlitz runs upwards.

If passing emotions can have such a pronounced influence upon writing, how much greater must be the effect when the centre or centres in the brain that control the writing mechanism are affected or destroyed by disease.

A study of the permanent alterations that may thus be brought about in handwriting possesses far more than a merely pathological interest, for it must eventually help to make clear many obscure points with regard to the mode in which written speech is produced and the nature of its connection with vocal speech.

In addition to such *impressive* disturbances of handwriting, due to impairment of the central control, there are other alterations of an *expressive* nature, in which without any loss of intelligence there is mechanical inability to make the co-ordinated movements that produce written characters.

In some of these cases the writing is of the kind commonly known as *atactic*, and is comparable with the marks made by a child in its early attempts to write. In others there is *tremor-writing*, which has its normal counterpart in the trembling writing of old people. In the example given in Fig. 2 the lines were written by a Scotch poet at the age of 92, and although the writing is, on the whole, remarkably firm and vigorous, many of the letters show clear indications of the shaking hand of old age.

In the complaint known as writer's cramp the hand can be freely moved and used for most purposes, but whenever any attempt is made to write, the muscles in the hand and arm contract, and cause the writing to be atactic and trembling, and eventually all power of writing may be lost. The specimen shown in Fig. 3 was written by a patient of Professor Lombroso.

Another significant disturbance of writing is that resulting from St. Vitus' dance, a complaint characterised by sudden and rapid involuntary muscular twitchings, which are often so uncontrollable as to merit the description applied to them by Moebius of a "witches' sabbath of the muscles." The spasmodic action of the hand is unmistakably shown in the jerky and unbridled writing reproduced in Fig. 4.

1804. After being crowned Emperor.

1805, Dec. 2. Signature on proc'amation after the victory at Austerlitz.

1806. After the campaign of 1806.

1812, Sept. 21. After entrance into burning Moscow.

1812, Oct. On the retreat from Russia.

1813, Oct. 23. Signature to a document signed at Erfurt. After the defeat at Leipzic.

1814, April 4. Fontainebleau, prior to abdication.

At St Helena.

Fig. 1.—Signatures of Napoleon at different periods.

Extreme instances of atactic writing, which need not necessarily be accompanied by any pronounced impairment of intelligence, are of common occurrence in certain stages of general paralysis. The writer may be

quite clear as to what he wishes to say, but is unable to compel the muscles of his hand to make the letters. In the examples shown in Fig. 5, which were written by the same individual at different times, it will be noticed that the letters at the beginning of the words are fairly well formed, but that as the concentration of effort became spent the writing grew more uncontrolled, so that the words end in illegible marks.

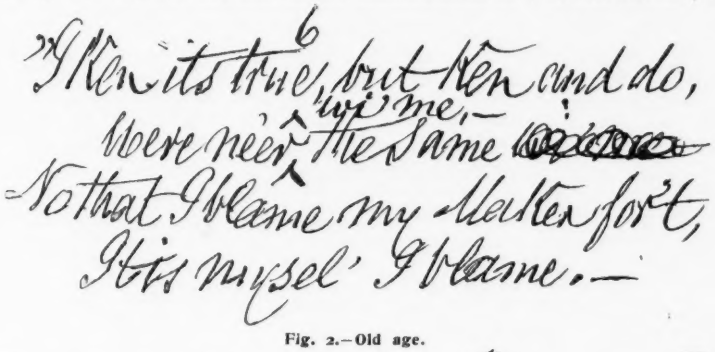

Fig. 2.—Old age.

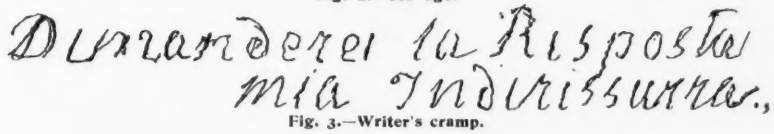

Fig. 3.—Writer's cramp.

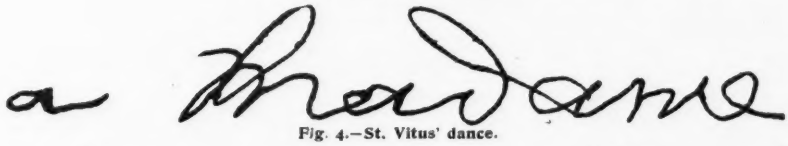

Fig. 4.—St. Vitus' dance.

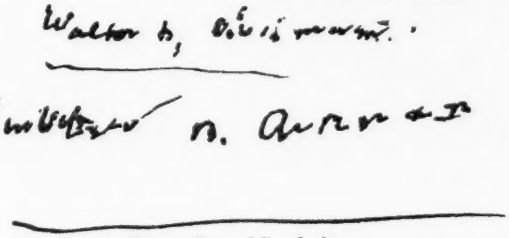

Fig. 5.—General Paralysis.

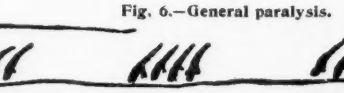

Fig. 6.—General paralysis.

Fig. 7.—Agraphia.

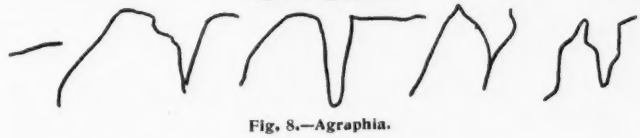

Fig. 8.—Agraphia.

In other cases of general paralysis there may be more control over the formation of the letters, but there is a tendency to multiply them or repeat them in the wrong places. Thus, in the writing shown in Fig. 6, the patient wrote "Garigalr" for "Garibaldi," the wrong letters evidently being made while the brain was still acting under the suggestion of the preceding "G" and "r." In this instance the anomaly in the handwriting is almost more of an *impressive* than an *expressive* nature (though defective formation of the letters is also obvious) and in this respect it resembles what is termed *agraphic* writing.

In typical *agraphia* there is either complete inability to write, the patient merely making aimless strokes in place of letters (see Fig. 7), or else only parts of letters may be formed (Fig. 8), or the same letter may be endlessly repeated, under the impression that sentences are being written.

The subject of *agraphia* or defective (or absence of) written speech due to lesions in the brain is closely associated with *aphasia*, or defective (or absence of) vocal speech due to the same cause. In fact, as Dr. Bastian* has pointed out, there is no recorded case of agraphia uncomplicated by aphasia, although instances are common in which defects of writing have been more pronounced and persistent than defects of speech, and *vice versâ*.

This close relationship between the two disorders is emphasised in the numerous diagrams that have been drawn to illustrate the supposed mode of action of the hypothetical speech centres.

According to the view still widely held, external speech (*i.e.*, vocal speech, writing, speech of the deaf and dumb) is to be regarded as depending upon visual, auditory, and kinæsthetic memories registered in special areas in the left hemisphere of the brain, injury to each of which will produce its particular form of aphasia or agraphia (see Fig. 9).

The theory of specialised speech centres originated in a series of striking observations by Broca, who, in 1861, found that there were lesions in the third frontal convolutions (F_3) of the left hemispheres of the brains of individuals who, during life, had been aphasic. For long afterwards it was believed that all cases of aphasia or agraphia were associated with lesions in that area of the brain, but, subsequently, it was discovered that other parts of the left hemisphere might be involved.

In 1874 Wernicke discovered lesions in the angular gyrus (T_1) in the case of two patients who had suffered from "word-deafness" (*i.e.*, inability to speak or write properly from dictation, but without loss of the power to copy).

This part of the brain was, therefore, termed the "auditory speech centre" or "Wernicke's area"; and another area was fixed upon as the "visual speech centre" (P_1), injury to which would cause "word-

* "Aphasia and Other Speech Defects," p. 108.

blindness" or inability to grasp the meaning of written words, but without loss of the capacity of speaking or writing to dictation.

With regard to the "graphic speech centre" or "writing centre," which, in Bernard's diagram, is placed in the second frontal convolution, F_2, there has long been controversy. Thus Elder* concluded that there was no decisive evidence of the existence of a separate writing centre in the brain, whereas others (*e.g.*, Bastian and Charcot) held the opposite view, and considered that lesions in that area should produce agraphia without vocal speech being affected. Dejerine, again, regarded the writing centre as only a part of the motor centre directing the co-ordinated movements of the limbs.

Recent work on the subject of *apraxia*, or loss of the power to perform skilled movements with the limbs, in the absence of paralysis or intellectual defects, a critical review of which has been made by Wilson†, supports this view of Dejerine. The clinical and pathological evidence indicates that the areas involved are the first and second frontal convolutions F_1 and F_2,

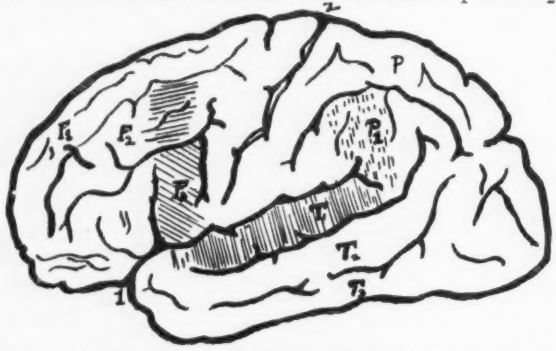

Fig. 9.—Outline of left hemisphere of the Brain showing position of lesion in different forms of aphasia (after Bernard).

1.—Fissure of Sylvius. 2.—Fissure of Rolando.
F_1, F_2, F_3.—First, second, and third frontal convolutions.
T_1, T_2, T_3.—First, second, and third temporal convolutions.
P_1.—Inferior parietal lobule, or angular gyrus.
Shaded area in T_1 represents position of auditory speech centre.
" " F_3 " " " motor vocal speech centre (Broca's area).
" " P_1 " " " visual speech centre.
" " F_2 " " " graphic speech centre.

and that injury to these causes inability to perform certain complex movements such as writing.

The various kinds of aphasia (including agraphia) are classified into the following main groups:—

1. *True* or *complete aphasia* regarded as the result of lesions in the three centres (visual, auditory, and motor or graphic areas).

2. *Motor aphasia*, due to lesion in Broca's area or graphic centre, involving loss of power of speaking, voluntary writing, or writing to dictation, but capacity to understand what is said or to read written words.

3. *Sensory* or *receptive aphasia*, in which the power of reading aloud or writing is retained, but without understanding of the meaning of the words.

4. *Intra-central* or *conduction aphasia*, attributed to derangement of the connections between the centres, and resulting in *paraphasia* or *paragraphia*, in which words or letters are misplaced or the wrong words are used to express the meaning (see Fig. 11).

The third group might be subdivided, as regards writing, into *auditory agraphia* in which there is inability to write voluntarily or to dictation, but power of copying; and *visual agraphia* in which there is inability to copy, but power of writing voluntarily and to dictation.

The various terms used in this classification will probably be retained as convenient descriptions, even if the explanations upon which they are based be ultimately discarded.

The theory that the differences observed in the different varieties of aphasia were due to their having their origin in different speech centres was almost universally held, until about three years ago, when Dr. Marie published his *Revision de la question de l'aphasie**, which has already become classical.

Marie's view, which he supports by many strong arguments and examples, is that the evidence of the existence of the separate speech centres is unconvincing, since it is based upon conjecture from the living subject, and the superficial pathological appearance of the brain after death, and not upon serial microscopical examination. In his opinion there is only a single speech centre situated in an undefined area in the region

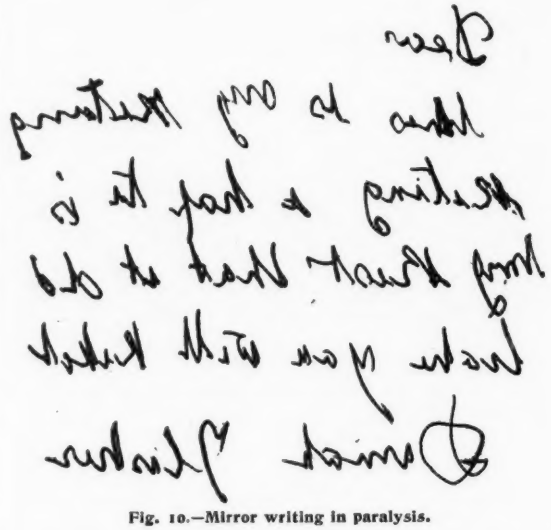

Fig. 10.—Mirror writing in paralysis.

of the angular gyrus (P_1), and the various kinds of aphasia commonly attributed to lesions in one or more of the "speech centres" owe their differences to the degree of injury in this one centre, and not to the injuries being in different places.

He suggests that in the numerous cases in which lesions have been found in Broca's area (F_3) stricter examination would have detected them in other areas also, and his experience leads him to the conclusion that Broca's area plays no part in the mechanism of speech.

Marie's theory and, in particular, his views about Broca's area have been hotly contested, notably by Dejerine and his supporters, and the controversy still continues.

Dr. Collier†, balancing the arguments on both sides, concludes that, while Marie's view of a single central speech centre will probably gain general acceptance, the evidence is still in favour of the retention of Broca's area as an important motor speech centre, *i.e.*, on the outgoing side. The work on apraxia, to which allusion has been made, also points to a similar conclusion of a speech motor centre.

The function of the right hemisphere of the brain in

* *Lancet*, 1897, I., 245. † *Brain*, 1908, XXXI., 164.

* *La Semaine Medicale*, 1906, *p.* 241. † *Brain*, 1908, XXXI., 523.

the acts of vocal speech and writing is probably subordinate to the action of the area or areas involved in the left hemisphere; at all events, in the case of right-handed people. In left-handed people, however, it is probable that the main speech and writing centres are in the right hemisphere, and that then the corresponding areas in the left hemisphere play the subordinate part.

The so-called "mirror writing" to which allusion was made in the previous article in this journal ("KNOWLEDGE," 1908, p. 256) throws an important light upon this question. It is not improbable that when there is an injury to the left-hand centre there is gradual adaptation of the corresponding centre in the right hemisphere to do the work; and a rapid process of adaptation would also account for the fact that it is only in a small proportion of cases that the first attempts to write with the left hand (or with the right hand in the case of left-handed people) result in reversed or mirror writing.

Thus Dr. Elder found that out of 451 individuals only 23 produced mirror writing when they first tried to write with the left hand.

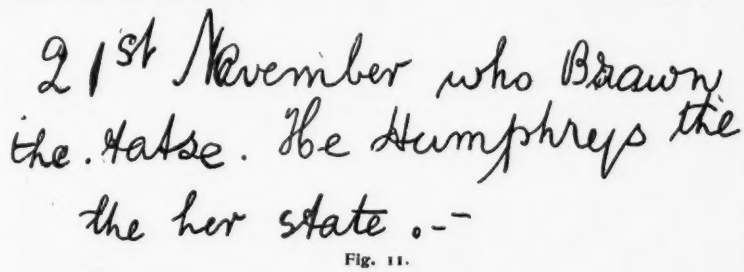

Fig. 11.

Fig. 12.—Paralysis.

The phenomenon is not uncommon in cases of paralysis, as was first recorded in 1878 by Buchwald, with whom originated the term of *Spiegelschrift* or *mirror writing*. An instance that has recently come under the writer's observation is here reproduced (Fig. 10). This represents the ordinary writing of a working woman of about 65, who for the last two years has been paralysed in the right arm, and since then has produced mirror writing with her left hand. It will be noticed that some of the letters are written in the ordinary way, and this may be accounted for on the assumption of a certain degree of adaptation having taken place in the right hemisphere of the brain.

The most interesting instance of mirror writing on record is to be seen in the last manuscript of Leonardo da Vinci, known as the *Codex Atlanticus*, in the library in Milan. Various speculations have been made as to why backward writing should have been employed here, but the obvious explanation may be deduced from the letter of a monk named Antonio de Beatis, who, after visiting Leonardo in his retirement at Amboise, wrote that the artist would never paint again as his right arm was paralysed.

The possibility of the right speech centre taking over the function of the left centre is indicated in the case of a young man of 25 who was paralysed on the right side, and suffered from complete vocal aphasia, and from agraphia in which the letters were well formed, but the words were confused. His writing is shown in Fig. 11 reproduced here by permission of Dr. Byrom Bramwell. In a few months there was complete temporary recovery from the agraphia and some improvement in the vocal aphasia, which Dr. Bramwell attributed to the above-mentioned adaptation of the correlative centre in the other hemisphere.

Another example of paralytic writing, for which I am also indebted to Dr. Bramwell, is that shown in Fig. 12. This is particularly interesting, owing to the fact that the agraphia was due in the main, at all events, to paralysis on the left side. There was word-blindness and paragraphia, and the man invariably introduced too many letters into words as well known as his own name and "Edinburgh," which is what he has here attempted to write. There was no loss of vocal speech, but words were produced in a slow and hesitating manner.

The writing of insane people almost invariably shows the effect of mental disturbance. In some cases the form of the letters is changed, but they are still used in their right places. An illustration of this is given in the signatures of the poet Lenau before and during his insanity, which are reproduced in Fig. 13.

In other instances there is both alteration in the form of the writing and paragraphia or use of the wrong letters. Thus Hölderlin, the German poet, who became harmlessly insane in 1806 at the age of 36 and remained so until his death in 1843, invariably misspelled his name in the manner shown in Fig. 14, which represents his writing before and during insanity.

Acute mania may make its effects manifest by great irregularities in writing. Not infrequently large printed capitals and small script letters are used indiscriminately, as in the example shown in Fig. 15. The words may be made excessively large or very minute, and, as is common in all cases of insanity, notes of exclamation are often scattered about plentifully.

The handwriting of those afflicted with monomania presents numerous points of interest. It is frequently

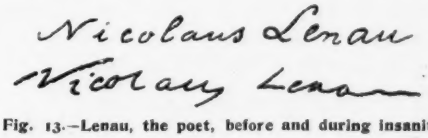

Fig. 13.—Lenau, the poet, before and during insanity.

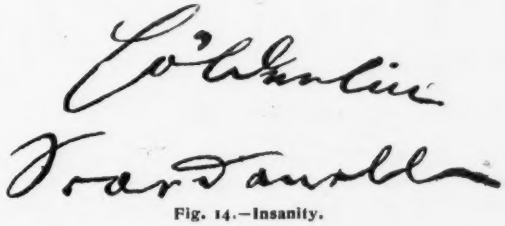

Fig. 14.—Insanity.

written in very small characters, and the words and lines are often placed vertically or crowded into corners when there is no lack of space elsewhere. In other cases, however, the writing shows signs of excessive

care in the formation of the letters, and is extraordinarily clear, bold, and regular. Many monomaniacs use a special symbol for each letter of the alphabet, while others invariably make use of crude drawings to help to elucidate their ideas. A curious example of this mode of expression is shown in Fig. 16, which represents the writing and drawing of a patient of Professor Lombroso.

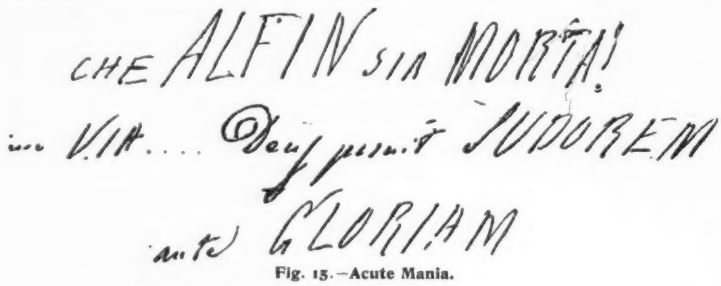

Fig. 15.—Acute Mania.

Fig. 16.—Monomania.

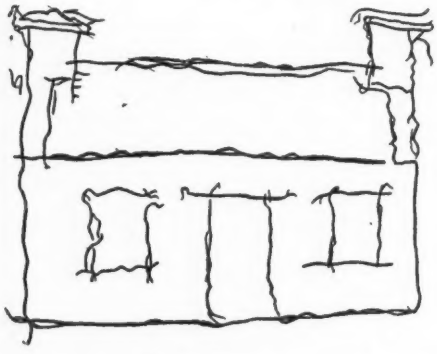

Fig. 17.—Paralysis.

This reversion in insanity to the use of symbols and drawings is obviously of an atavistic nature, for it was originally by way of symbols that writing was evolved.

A confirmation of this idea is found in a remarkable case of agraphia that came under the notice of Dr. Bramwell. There was pronounced word-blindness, characterised, however, by the peculiarity that the patient, who had been paralysed in the right arm, had the power of reading words, but not of recognising individual letters. There was also no power of writing spontaneously or from dictation, but writing could be copied with the left hand. The patient could also draw with the left hand and could recognise the different parts of a house he had drawn (see Fig. 17) when they were named to him, but was quite unable to recognise the letters of the alphabet when they were read over to him. In this case, then, it would appear that some power of expressing ideas by means of drawing had been retained after the capacity of expression by writing had been lost. Other instances of this tendency to revert to symbolism might be cited, but the two given above are sufficient in the way of illustration. For permission to reproduce the first of these and several of the other specimens the writer desires to give his best thanks to Professor Lombroso,* while he has been enabled to give the other through the kindness of Dr. Byrom Bramwell, to whom he also tenders his thanks.

Combating Injurious Insects with the aid of their Natural Enemies.

AN interesting instance of successful warfare waged against injurious insects with the aid of their natural enemies is reported from Hawaii, where the sugar plantations have in recent years been threatened with annihilation by the ravages of a small cicada, little more than $\frac{1}{8}$-inch long. Prof. Kirkaldy, the director of the Honolulu entomological station, has described the little insect and named it *Parkinsiella saccharicida*. It pierces the stem of the sugar cane and extracts the sap, causing the plant to wither and die. The formidable character of this insect pest is due to the amazing rapidity with which it multiplies. Six generations are produced annually and, on the assumption that 20 females of each brood live to reproduce their kind, it is estimated that the progeny of one female produced in the course of a single year numbers 64 millions. The insect was undoubtedly introduced with the sugar cane from other countries into Hawaii, where it has multiplied enormously, as its natural enemies, which limit its numbers elsewhere, do not appear to have been imported with it. Entomologists were, therefore, sent abroad to discover the original home of the little cicada, to find its natural enemies, and to bring these to Hawaii. It was necessary to extend these laborious and costly investigations to every part of the world from which sugar cane plants had been imported. The home of the insect was finally located in Australia, where two of its most formidable enemies were also found. These are two species of ichneumon fly, of the genera *Paranargus* and *Ovetertastichus*, which lay their eggs in the eggs of the cicada. The first-named species destroys only the cicada eggs in which its own eggs are deposited, but the other species pierces only one egg of each cluster of cicada eggs and its larva destroys the entire cluster. Both species have been successfully colonised in Hawaii and the prodigious increase of the sugar cane cicada has thus been checked.—*Scientific American.*

* The death of Professor Lombroso occurred while this article was in the press.

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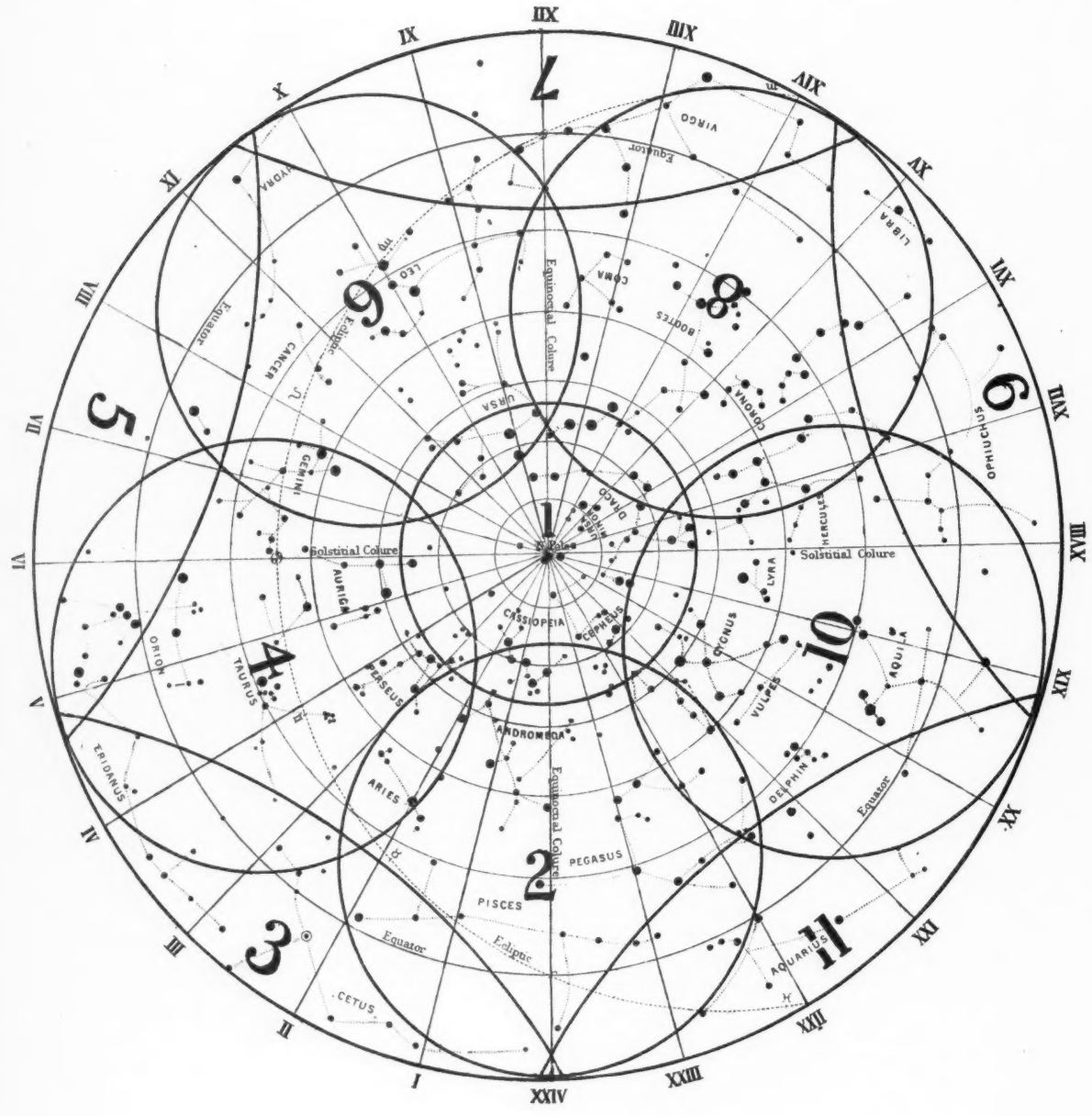
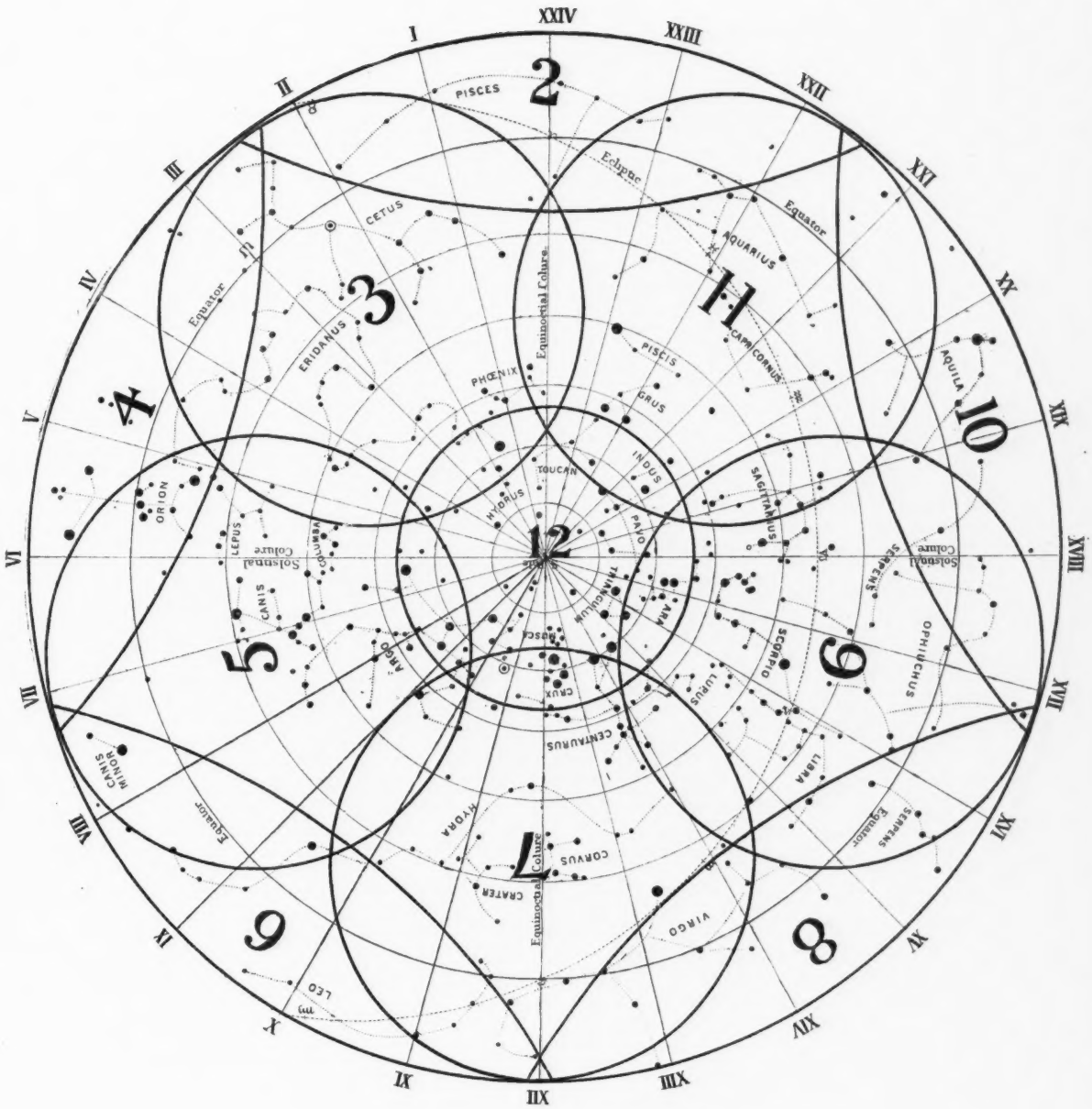


KEY TO STAR MAPS.

(Northern Hemisphere).



KEY TO STAR MAPS.

(Southern Hemisphere).

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Astronomical Superstitions.*

By JOHN CANDEE DEAN.
INDIANAPOLIS, IND.

THE great majority of our superstitions had their birth in attempts to interpret natural phenomena from erroneous ideas which consist of fancies suggested by the imagination. In other words, most superstitions are attempted short cuts to explain phenomena while omitting natural causation. The average man loves superstition, loves the fictitious, both loves and fears the supernatural and is fascinated by the incomprehensible. From the infancy of the human race men have attempted to explain things according to their external appearances, and whatever was strange or vast, especially if it had visible motion, impressed the beholder with the fear of invisible powers.

During September, 1908, a score of people called the writer by telephone to ask about a brilliant star that had appeared in the eastern morning sky. They had been informed that it was the star of Bethlehem, which appears only once every 300 years. They generally seemed disappointed when told that it was not the star of Bethlehem, but the planet Venus, which, instead of becoming visible only once in 300 years, regularly appears twice in a period of 584 days. On attempting to impart further information it soon became evident that their interest was in the *mystery* of the star of Bethlehem and not in any *facts* relating to Venus.

Fashionable society will enthusiastically discuss telepathy, astrology, christian science, psychic force, palmistry, spiritualism, etc., but if one should introduce a subject relating to astronomy or physics, he would be regarded as a pedantic bore. Du Maurier illustrated the indifference of society to science by a drawing in *Punch* entitled "Science and Music at an Evening Party." The scene was in a large London drawing-room. In the foreground was a professor earnestly talking to a gentleman, while at the back of the room all the rest of the company were eagerly crowding round a piano. Chesterfield wrote to his son:

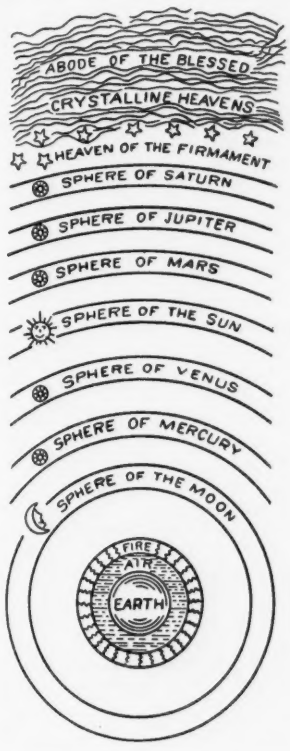
> Pocket all your knowledge with your watch and never pull it out in company unless desired; the producing of one unasked, implies that you are weary of the company, and production of the other will make the company weary of you.

While it is true that there is but a small circle of people interested in what is called physical science, yet that science now rules the world and is nearly as despotic as Nature herself. Human progress is almost entirely scientific and even our industrial progress is based on applied science.

Even before man essayed to group the stars into constellations he naturally raised the question of the origin, and the manner of the production, of the world itself. He then believed it to be flat and immovable, and its seagirt disc supported the sapphire vault above. Gods, men, monsters and heroes familiarly associated and acted their parts, before man had learned to judge by evidence and to place a limit on probability. The sun, the moon, and the earth were living beings filled with demons, and sorcery governed belief. Under these conditions there arose no astronomical or geographical difficulties, for where superstition rules evidence becomes useless.

The astronomical ideas of primitive people have been similar the world over. The cosmogony of the Mohammedans, as presented in the Koran, is so puerile as to be unworthy of serious consideration. It teaches that the earth is flat and floats in the sea. It is kept in balance by the mountains, and the sky is supported above by a huge dome so perfect that it is impossible to discover a crack in it. Above are the seven heavens, ranged one over the other, the uppermost being the abode of God, which does not rest on the earth, but is supported by winged animals. Meteors are red-hot stones thrown by angels at bad spirits when they approach too near the seventh heaven. Of the many creation myths, the Jewish story is the one most familiar to us. According to this narrative the universe was miraculously created in six days. The earth is the fixed centre enclosed in a great hemisphere called the firmament, which divides the seas above it from those below. More space is devoted to describing the creation of the firmament—now known to be an optical illusion—than to the creation of man himself. The sun, moon, and stars were made "to give light upon the earth," and the whole universe was purely anthropocentric, that is, man was the pre-ordained centre and aim of all creation. This anthropocentric dogma is closely connected with all three of the great Mediterranean religions, Mosaic, Mohammedan, and Christian, hence it has for centuries dominated the beliefs of the greater part of the civilised world.

Many of the most charming legends of Greek and Roman mythology were drawn from astronomical subjects. There is no more beautiful illustration of Roman superstition than that shown in Guido's familiar fresco of "Aurora." Why this picture is called Aurora and not Apollo is difficult to explain. The noble sun god is the most important figure of the picture, and he dominates all the rest. He is surrounded by the light tripping Hours, each a very queen of loveliness. Aurora, the goddess of the dawn, leads the throng. From the crown of her beautiful head to the soles of her rosy feet she is grace incarnate. As she flies she scatters flowers and dew from her hands upon the verdant fields below.



ANCIENT THEORY OF THE UNIVERSE

The Roman child was taught that the sun was the actual wheel of Apollo's chariot. In the morning this god arose from the eastern sea driving his four wonderful horses across the heavens; in the evening he descended into the western sea; at night he slept in a golden boat which was borne along the northern edge of the earth to the rising place in the east. The moon was the abode of the lovely goddess Luna, sister of Apollo, who guided its course in the heavens.

Thus mythology explained astronomical phenomena; the sun, moon, planets, clouds, dawn, and night with its black

* Reprinted from the *Popular Science Monthly*, New York.

mantle bespangled with stars, became animated things. The sun, when setting in the brilliant evening clouds, then became Hercules in the fiery pile.

While mythology obstructed scientific progress by finding sacred explanations for every natural event, there were a few gifted, inquisitive minds among the Greeks that sought for knowledge behind the painted curtain of superstition. Thales, of the sixth century B.C., was the father of Greek astronomy. He taught that the earth is spherical and that the moon receives her light from the sun. Anaxagoras ascribed eclipses of the moon to natural causes and taught the existence of a creative intelligence. He fell a victim to the superstitions of his age. Sentence of death was passed on him and his family, which required all the eloquence of his friend Pericles to commute to banishment.

Pythagoras, of the fourth century B.C., was a most assiduous enquirer. He is said to have been the first to propose the system of a globular earth and of planets, revolving around the sun. When the Church condemned the theory of Copernicus the indictment was that it was heathenism and Pythagorean.

Modern astronomy may be said to have arisen in the third century B.C., under the patronage of the first king of the Greek dynasty, at Alexandria, Egypt. Euclid, Eratosthenes, Hipparchus, and Ptolemy were among the illustrious astronomers of the Alexandrian era. It was in the second century A.D. that Ptolemy published his great work on astronomy called the "Almagest," which, during the following fourteen centuries was universally regarded as a kind of astronomical bible.

One of the curious astronomical superstitions that originated with the Chaldeans, and which persisted almost to our own times, was that of the crystalline spheres. The idea of a spherical universe was a very natural one. It was difficult to see how thousands of bodies could revolve around the earth for generations without change in their relative positions, unless there was something to retain them in their places. It was believed that the planets and stars were set in a series of concentric orbs or spheres, each so perfectly transparent that bodies in the outer ones were visible through all the intervening ones. The drawing shows the order of the spheres and the system of the universe according to Ptolemy. The earth is in the centre enclosed by the sphere of the moon, beyond are the concentric spheres of Mercury, Venus, the sun, Mars, Jupiter, and Saturn. Outside of all are the crystalline heavens and the abode of the blessed.

The revolution of the spheres was supposed to produce the most exquisite music which filled all celestial space, but such was its refined quality that it was inaudible to mortal ears. One of the most sublime passages of Shakespeare describes this music:—

> Sit, Jessica. Look how the floor of heaven
> Is thick inlaid with patines of bright gold.
> There is not the smallest orb which thou beholdest
> But in his motion like an angel sings,
> Still quiring to the young-eyed cherubims:
> Such harmony is in immortal souls;
> But while this muddy vesture of decay
> Doth grossly close it in, *we* can not hear it.

The following parallel lines are from Milton's "Arcades":—

> In deep of night when drowsiness
> Hath lock'd up mortal sense, then listen I
> To the celestial Sirens harmony,
> That sits upon the nine infolded spheres.
> Such sweet compulsion doth in music lie,
> To lull the daughter of Necessity
> And keep unsteady Nature to her law,
> And the low world in measured motion draw
> After the heavenly tune which none can hear
> Of human mould, with gross unpurged ear.

Astronomy has always been the favourite science of the poets. The framework of Dante's "Paradise" is constructed on the Ptolemaic system. His ten heavens are arranged in the exact order of those shown in the drawing. The crystal orbs are rotated by angels. He says:—

> The virtue and motion of the sacred orbs,
> As mallet by the workman's hand must needs
> By blessed movers be inspired.

It may be said that during the Christian era, up to the thirteenth century in which Dante lived, there had been no progress in scientific knowledge. He still held to the four elements of the Greeks:—

> Thou sayest, the air, the fire I see,
> The earth and water, and all things of them
> Compounded, to corruption turn and soon
> Dissolve.

Although Shakespeare was not born until twenty years after the death of Copernicus, all allusions made by him to the heavens are either astrological or Ptolemaic.

The tendency of a superstition to persist even after closely allied phenomena have been explained on a purely natural basis is illustrated in the belief that planetary motion was due to "blessed movers." Although Copernicus discovered that the planets revolve around the sun instead of the earth, he still believed that their motion was controlled by guiding spirits. Galileo conclusively confirmed the correctness of the heliocentric theory, but faith in the supernatural motion of the planets was undisturbed. Not until the genius of Newton had discovered and formulated the law of universal gravitation and provided a mathematical foundation for Kepler's laws were these conducting spirits dismissed. It required the discoveries of three men of genius and two centuries of time to overthrow the foolish superstition of mediocre man.

From the end of the fourth to the beginning of the fifteenth century superstition had given to society a form that prevented the man of genius from being heard. Buckle says that from the sixth to the tenth century there were not in all Europe more than three men who dared to think for themselves, and through fear of punishment even they were obliged to veil their meaning in mystical language. The remaining part of society was sunk in degrading ignorance. Progress became possible only when science essayed to explain observed phenomena by depending on natural causation.

For ages the superstitions of astrology ruled the world by the terror that they inspired. The figure of a man, with entrails exposed, in the front of the family almanac is a survival of Egyptian astrology. Around the figure are the twelve signs of the zodiac with lines extending to the parts of the body supposed to be influenced by the celestial signs. Aries the head, Leo the heart, Capricornus the knees, Pisces the feet, etc. Faith in the influence of the signs of the zodiac remained unshaken in spite of knowledge that the inconstant stars were shifting from one sign to another by the precession of the equinoxes. When the pyramids were built, what is now known as the pole star was so far from the celestial pole that the Egyptians saw it rise and set in the Mediterranean. The Southern Cross was then visible not only in northern Egypt, but throughout Europe as far north as London.

Coincidences have ever been mistaken for causes. Owing to the unparalleled brilliancy of the Dog Star, astrologists assigned to it powerful influences, and because it rose just before the sun, at the season when the Nile overflowed, it was supposed to be the mystic cause of the inundation. They gave it the name of Sirius,

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from the river Nile, which was called Siris in their hieroglyphics. They also called it the Dog Star because, like a faithful watch-dog, it warned them of the approaching overflow, and they waited for its appearance with deep solicitude, for on the overflow of the river depended agricultural prosperity or blighting drought. They computed the length of the year from the heliacal rising of the Dog Star, and this is still known as the *Canicular year*. The Romans were equally solicitous and were accustomed to sacrifice a dog to Sirius, to render his influence beneficent to agriculture. Virgil says:—

> Parched was the grass, and blighted was the corn:
> Nor 'scaped the beasts; for Sirius from on high,
> With pestilential heat infects the sky.

The time of the year when the Dog Star rose with the sun and appeared to combine its influence with the solar heat they gave the name "dog days" (*dies canicularis*), which began August 4 and ended September 14. Owing to the displacement of the constellations by precession, the time of the heliacal rising of the Dog Star is continually accelerated, hence modern dog days have no connection with this star, and, furthermore, recent study of rabies proves that more dogs go mad in winter or early spring than in summer time.

A favourite prediction of astrologers was of cataclysms that would destroy all mankind. Such a catastrophe was foretold to occur in 1186, and a universal deluge was predicted for the year 1542. In the latter year there was to be a conjunction of three planets in the watery sign of the "Fishes." The prophecy was generally believed and the terror was widespread. A Noah's ark was built at Toulouse, but the year was distinguished for its drought.

Ridicule is sometimes more efficacious than argument in overthrowing false theories. A skit by Dean Swift discredited astrology, in England, more than all the evidence of science. Swift published a satirical pamphlet under the title of "Predictions for the Year 1708, by Isaac Bickerstaff, Esq.," in which he predicted the death of a well-known astrologer and almanac maker by the name of Partridge. He claimed to have consulted the stars and calculated the exact hour of the astrologer's demise. This was followed by a letter to a man of rank, giving complete particulars of Partridge's death on the day and almost at the very hour foretold. The angry astrologer denounced the pamphleteer, employed a literary friend to write up proofs of his existence, and published his almanac for the year 1709. Swift answered all of the arguments, claiming that the denial of death was spurious, and that the deceased was a gentleman who would never have used the abusive language employed; as for the almanac, everybody knew that almanacs were frequently published under the names of people who had long been dead.

An adequate account of the superstitions of astrology would make a volume, and it would be easy to compile a list of one hundred lunar superstitions that still govern the actions of the uninformed. For example, the new moon if first seen over the right shoulder will bring good luck. If seen over the left shoulder, bad luck. Meat killed when the moon is waning shrinks in the pot. Whatever grows above ground must be planted when the moon is waxing. Whatever grows underground must be planted when the moon is waning. One of the commonest lunar superstitions is that the changes of the moon, at the quarter, affect the weather, and many of our almanacs still publish so-called "Herschel's weather tables," for foretelling changes of the weather, not only throughout all the lunations of the year, but for all future time. We are assured by the almanac makers that the tables are the result of careful consideration of the attractions of the sun and the moon "and so near the truth as to seldom or never fail." Belief in the moon's influence over terrestrial conditions is a mild lunacy by no means wholly confined to the ignorant. A tabulated meteorological record, kept at Greenwich running back for forty years, shows that there are no constant relations between the moon's columns and those recording the readings of the instruments. In other words, lunar meteorological influences are almost inappreciable. Idle fancies are still cherished that the mind and body are affected by the light of the moon, that the rays sometimes produce blindness by shining on the sleeper's eyes, and that death occurs at the time of the changes of tide.

When Copernicus published his work on the "Revolutions of the Heavenly Bodies," in 1543, he was already on his deathbed. A few men of learning read it, the doctors of the church rejected it, and it received but little attention until the time of Bruno, Galileo, and Kepler, half a century later. During the previous thirteen hundred years the astronomical system of Ptolemy had been regarded with superstitious reverence. It was natural that a geocentric and anthropocentric universe should be drawn, because these errors were conducive to man's interests, pleasing to his extreme egotism, and resulted in the apotheosis of himself. The anthropocentric dogma culminated in the belief that *man* was the pre-ordained centre and aim of all creation, while the new heliocentric mechanism of the planetary system relegated both the earth and man to subordinate positions.

In 1610 Galileo ascended the tall campanile of St. Mark's, in Venice, and with his newly devised telescope showed the assembled noblemen and senators that Venus was a crescent, Jupiter the centre of a miniature Copernican system, the moon had tall mountains casting dark shadows across her surface, that the star cluster of the Pleiades contained not seven stars, but thirty-six, and that the Milky Way was powdered with stars. In reward for his discoveries the Venetian Senate doubled his salary of professor at Padua, and secured that position to him for life. He was made Philosopher Extraordinary to the Grand Duke of Tuscany, and the next year visited Rome, where he exhibited the wonders of the heavens to the eminent personages of the Pope's court.

But war on Galileo soon flamed forth. The spiritual authorities saw that established dogmas were endangered. He was accused of heresy and atheism. The story of his summons before the inquisition, his trial, conviction, and suffering has been told too often to be repeated here. The triumph of superstition over his astronomical discoveries was for the time complete. This great genius lived to see his works expelled from all the universities of Europe, their publication prohibited, and he knew that he was doomed to face all posterity as one who had committed perjury to escape torture.

Sixteen years previous to Galileo's first summons to Rome, poor Giordano Bruna was burned in that city. In his wanderings to escape persecution Bruno had visited England and while there published his exposition of the Copernican system. Prudence frequently obliged him to change his place of residence, and it is not strange that he finally drifted to Venice. Here greater religious liberty was permitted than in other Italian cities, and here the stake had never been erected. It was at the Palazzo Mocenigo, on the Grand Canal, that emissaries of the inquisition finally ran him to earth.

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The first indictment of the inquisition charged him with teaching that there were innumerable worlds. He was burned to death in the Piazzo Campo di Fiore in the year 1600. Galileo's greatest contemporary was Kepler, who discovered the laws of planetary motion which paved the way to the greater discoveries of Newton. Kepler was abused, imprisoned, and warned that he must bring his theories into harmony with the Scriptures. Astronomy was then so poorly patronised that to increase his meagre income he was obliged to pay homage to the astrological superstitions of Rudolph II. and Wallenstein.

One of Kepler's most terrible experiences arose from the prevailing superstition of sorcery. His aunt and his mother were charged with being witches and sentenced to be burned alive. Through Kepler's indefatigable efforts, and the influence of powerful friends, his mother was saved, but the suffering which she endured during more than a year's imprisonment resulted in her death a few months later. Kepler's aunt was burned at the stake.

The writings of all ages up to the eighteenth century show that comets were believed to be dire messengers of woe. Stars and meteors were generally thought to foretell happy events, especially the birth of heroes and great rulers. Eclipses expressed the distress of Nature over terrestrial calamities, while comets portended greater woes than all the other celestial signs combined. Those who did not recognise them as warnings from God were stigmatised as atheists and Epicureans. John Knox believed them to be tokens of the wrath of heaven, others saw in them warnings to the king to extirpate the Papists. Luther declared them to be the work of the devil and called them harlot stars. Milton says that the comet "from its horrid hair shakes pestilence and war." Whole nations from the king down to the lowest peasant were frequently plunged into the direst alarm by the appearance of these messengers of misery. The comet that appeared the year after the assassination of Cæsar was supposed to be his metamorphosed soul armed with fire and vengeance. It is said that the comet of 1556 had a powerful influence in causing the Emperor Charles V. to abdicate and retire to the monastery of San Yuste. Queen Elizabeth, in 1580, issued an order of prayers to avert God's wrath, and referred to comets, eclipses, and heavy falls of snow as evidences of His great displeasure. The periodic comet known as *Halley's* probably caused more consternation than any other within historic times. One of its early appearances was the year of the Norman Conquest, and it was supposed to presage the defeat of the Saxons and the death of Harold. At the South Kensington Museum is a copy of the Bayeux Tapestry on which may be seen the comet of 1066. Its return in 1456 spread a wider terror than was ever known before. The belief was general that the Judgment Day was at hand. People gave up all hope and prepared for their doom. Again in 1607 it alarmed the world by its appearance and the churches filled with terror-stricken multitudes. Kepler, who was then imperial astronomer at Prague, quietly traced its course and discovered that it was outside of the moon's orbit. Tycho had made the same observation respecting a bright comet that appeared thirty years earlier. The announcement of Kepler's discovery caused a great outcry, because it attacked the very foundations of the cometary superstitions. It also assailed the dogma of the crystalline spheres, because the motion of a superlunar comet would send it crashing through the spheres. It was hard for superstitious man to give up the "signs of the heavens" that had so long misguided him. As late as the latter part of the seventeenth century a book was published by Father De Angelis, of the Clementine College, Rome, in defence of the old cometary faith. He claimed that comets originate in our atmosphere below the moon. Everything heavenly is eternal. We see the beginning and ending of comets, hence they are not heavenly bodies. They are emanations of dry, fatty matter from the air and may be ignited by sparks from heaven or by lightning. Everyone knows that they cause war, pestilence, and famine. He had observed a comet at Naples which was so close that its tail almost touched Vesuvius, and it would have destroyed Naples but for the blood of the martyr Januarius.

People were so wedded to ancient errors that it required one hundred years of telescopic work to bring the Copernican system out of the realms of hypothesis. For generations the universities taught both the geocentric and the heliocentric systems, leaving the student to decide which was right. During more than a thousand years previous to Galileo's discoveries *superstition* and *unreason* had prevented all human progress. They were the source of untold mischief and suffering, and are still man's greatest enemy, while science and reason are his greatest friends. Modern superstitions are often the best comment on ancient astronomical errors.

Newton's astrophysical discoveries placed the solar system on a mechanical basis and dispensed with the planetary guiding angels. Empirical science has since shown that every phenomenon has its mechanical cause, while Darwin's "Descent of Man" has shattered the dogma of anthropocentricism. In the operation of cosmic forces it may now be said that events occur by mechanical necessity regardless of man's interests. During the latter half of the nineteenth century, by the telescopic study of the vast and the microscopic study of the small, a splendid record of accumulated truths was attained. The discoveries of the laws of the indestructibility of force and matter, the unity of Nature, the mechanical theory of heat; inorganic and organic evolution, and the universality of law have explained many mysterious phenomena and forced them out of the darkness of the supernatural to the light of the natural. It has been said that mystery has now been driven from the universe. Belief in the miraculous and the transcendental rests on the assumption that outside and beyond the natural world active forces exist that have no material basis, and of which we can learn nothing by experience, or by any natural means. Such dualistic beliefs are purely idealistic and are evolved from the activity of the brain called emotion. Emotion has nothing to do with the attainment of truth and all doctrines, or opinions, are to be suspected, that are favoured by our passions.

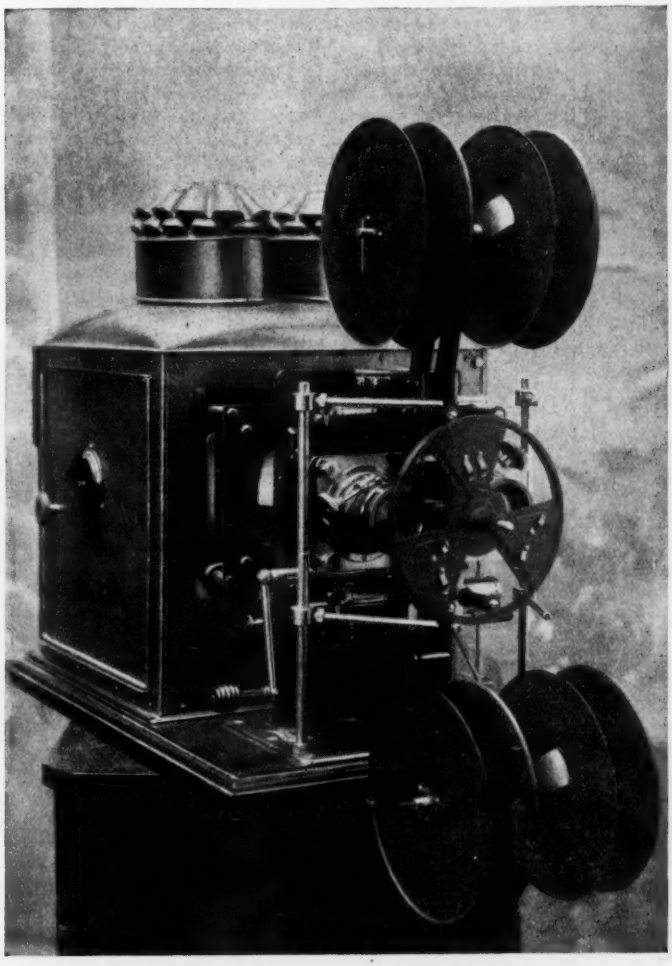
Philosophy is the science of which all others are but branches, hence philosophy lies in the province of physical science and not in that of letters. Haeckel says: "All true natural science is philosophy and all true philosophy is natural science." The astronomical errors of the past have arisen from attempts to explain the cosmos out of the inner consciousness, rejecting all scientific methods and substituting faith. While faith may supplement observation in the search for truth, we must not confuse supernatural faith with the natural faith of science. Mark Twain has defined the former as "believing something that you know is not true." The natural faith of science and of practical life is drawn from experience. Kant, Hume, Huxley, and Haeckel agree that all knowledge of the reality of phenomena is limited to that revealed to us by experience. Belief must rest on evidence. That belief which is not founded on evidence is both illogical and immoral.

XUM

Stereoscopic Projection in Moving Pictures.

By FRED A. TALBOT.

FOR some time past efforts towards increasing and improving the beauty of moving pictures have been made by attempting stereoscopic projection for the purpose of throwing the image into relief, and securing the same effect as when illustrations are viewed through Oliver Wendell Holmes' hand instrument. The main objection, however, has been in regard to the cost of the films, the only experiments made being with the simultaneous projection of two pictures. Such a method entails double the length of film requisite for single lantern projection.



The Stereoscopic Cinematograph.
The left-hand is being uncovered while the right is being covered by respective shutter segments of revolving disc.

An inventor, however, has now perfected and patented a process in which this objection is completely overcome. The lantern is of the side-by-side, bi-unial type with the lenses adjusted so that the images overlap on the screen throwing one single completely registered field of light, as in ordinary twin lantern projection. But the two lenses are not uncovered at one and the same time; that is to say, the picture from one half of the lantern is only projected on to the screen at one time, and not two self-same pictures together.

The shutter of the revolving type, centrally mounted in front of the lenses, is divided into suitable segments, and it is so arranged that in its revolution, while one lens is exposed, the other is covered, so that each lens is exposed alternately. It is the successive superimposition of the images when the lantern is operated rapidly, combined with the phenomena of visual persistence, that supplies the appearance of stereoscopy, and the effect is produced in a very striking manner.

In single lantern cinematographic projection, although the pictures thrown upon the screen at the rate of about 16 per second apparently show continuous motion, such is not the case. An infinitesimal period of motion is lost between each successive picture in the short period the lens is closed to admit of the successive section of film being jerked into place behind the lens, and although the eye does not realise the motion that is lost, yet it still has an impression of lack of continuity, colloquially described as "flicker," attributed to cutting in and out of the shutter, but which is, in reality, nothing more than the sharp line of demarcation between each period of movement, as represented by its individual instantaneous picture.

In the new process, however, no such flickering is observable. When the photograph is taken by means of a stereoscopic camera, working on the same principle of alternate exposures of the lenses, two complete films are secured of the same subject. Each of these is a truthful record of the movement photographed, and each, when thrown on the screen singly, is exactly the same as that now produced. Yet each film is a different record of the same subject, for the right-hand lens secures that phase of movement which the left misses while its shutter is closed, and *vice versâ*. The result is that the two films taken alternately when shown give an absolutely correct and continuous record of the movement photographed.

When, consequently, the two films are projected upon the screen, the effect is a perfect and truthful reproduction of continuous motion. The effect may be best likened to that of the camera obscura, only in relief. Nor does the process entail a greater length of film than would be requisite for single lantern working. For instance, suppose a picture record of 3,200 successive pictures is projected from a single lantern, the images must be projected at a speed of 16 per second, so that film record would occupy 200 seconds in showing. By the stereoscopic instrument the length of film for each half of the lantern would only be 1,600 pictures, and yet would contain the same record of the subject photographed, as the single film of double the length. In projection, as eight pictures are thrown from each lens per second, making a total of 16 per second from the two lenses, the time occupied in showing would be exactly the same. Consequently, no more film is required for a given record than in the ordinary case.

XUM

When projection is carried out slowly with the twin projector the image thrown on the screen is perfectly flat as at present. As the instrument is speeded up, however, the flatness disappears until, when at last a combined speed of 16 pictures or more per second from the two lenses is obtained, an impressive stereoscopic effect results. If desired, either side of the lantern can be thrown out of action, and the other used as a single lantern in the usual manner. With the two in use, however, as a picture is always on the screen, the shutter acting somewhat as a dissolver, there is no sign of flicker whatever. When used in connection with microscopical work the beauty of the stereoscopic projection is very pronounced.

Astronomy and Astrology.

By F. W. HENKEL, B.A., F.R.A.S.

FROM the earliest times down to the last two centuries no very clear distinction was made between astronomy and astrology. The former was often designated "natural" astrology, dealing with the movements and appearances of the heavenly bodies; the latter was called "judicial" astrology, and dealt with rules for determining their supposed influences upon terrestrial affairs, the destinies of individuals, especially of those "highly placed" in office. There seems little reason to doubt that it was a desire to know the nature of this supposed influence, especially as affecting themselves personally, that led to the patronage of the science by rulers. Astrologers were attached to the courts of the principal princes of Europe during the middle ages, and such astronomical work as they were allowed to perform was often undertaken with this end in view. "Astronomy would starve," exclaimed Kepler on one occasion, "were it not for her harum-scarum daughter Astrology." He himself, the illustrious discoverer of the three great laws of planetary motion, "Imperial Astronomer and Mathematician" to the Emperor Rudolph, was obliged to eke out his irregularly paid stipend by the money he earned from casting horoscopes and "fortune telling by the stars." Lord Bacon sometimes, though with little justice, considered the father of the inductive method, was a believer in a form of astrology, though he suggested that enquiry was necessary to determine the "just rules of the *Astrologia Sana*." In Shakespeare we find references to the belief in the influence of the stars on human fortunes. In *Henry IV.* we find Glendower saying: "At my nativity the front of heaven was full of fiery shapes of burning cressets." Chaucer alludes to the evil effects produced by Saturn:

> ". . . quoth Saturn,
> My course, that hath so wide for to turn,
> Hath more power than wot any man;
> Mine is the drenching in the sea so wan,
> Mine is the prison in the dark coat,
> Mine is the strangling and hanging by the throat,
> The murmur and the churls rebelling."

Each planet had assigned to it a particular metal and a distinctive colour, often, no doubt, suggested by its hue.

> "Sol gold is, and Luna silver we threpe,
> Mars iron, Mercury (quick-) silver we clepe;
> Saturn lead, and Jupiter is tin,
> And Venus copper, by my faderkin."
> ("Canon's Yeoman's Tale," Chaucer.)

The colours, by a more or less obvious analogy, were thus assigned to the sun and planets:—Yellow to the sun, azure blue to Mercury, red to Mars, black to Saturn, etc. The mediæval astrologers also assigned colours to the twelve signs of the zodiac, and particular districts were ruled over by each sign; thus Aries ruled over England, France, and Denmark; Taurus over Ireland, Holland, and Persia. The sign Gemini, in particular, was regarded as especially associated with the fortunes (or misfortunes) of London, and, accordingly, the plague, the great fire of London, and the building of London Bridge, were all associated with the position of this sign.

Lilly, the astrologer, is credited with having predicted the occurrence of the plague of 1665 and the great fire of 1666, which latter occurred at the time when part of the sign Gemini was in the ascendant of London. He was questioned by the House of Commons Committee appointed to enquire into the cause of the fire, and declared that he had discovered by his art that such an event was to happen, but disclaimed any knowledge as to its date or cause. It is not difficult to understand how some of the influences assigned to the heavenly bodies came to be attributed to them. Thus the sun, from his very evident influence on all terrestrial phenomena, and the moon, from her tidal action, being known to be potent factors, the idea naturally arose that others of the heavenly bodies might have powers as great as, or even greater than, these two over man's destiny. The fiery red colour of Mars seemed naturally to associate this planet with "wars and rumours of wars," the dull lustre and slow movements of Saturn as naturally indicated misfortune and "Saturnine influence," whilst the brilliancy of Jupiter and Venus led to their being considered fortunate planets. Mercury, too, always close to the sun and difficult to detect from his rapid motions, betokened volatile and choleric temperament. Yet how the astrologers came to devise the elaborate system by which every planet and each sign has its special influence is by no means easy to say.

In Whewell's opinion the sun, moon, and planets being identified with the gods and goddesses of the Greek and Roman mythology (still surviving in the names of the days of the week), the characters assigned to these deities were transferred to the stars bearing their names. Others there are who, with equal probability, consider that these mythological beliefs were suggested by astrological ideas, the character of Mars from the red colour of the planet of that name, the swift-footed Mercury (messenger of the gods) from the rapid movements of the planet, and the supremacy of Jupiter from the greater brightness of that star, and so forth. Nevertheless, though the belief in astrology was very general until quite recent times, there were always clear-minded thinkers who shook themselves free from the popular superstition. Shakespeare, in *King Lear*, says: "This is the excellent foppery of the world, that when we are sick in fortune we make guilty of our disasters *the sun, moon, and stars*, as if we were villains by *necessity*, fools by *heavenly compulsion*, knaves, thieves, and treacherous by *spherical predominance*," etc.

In earlier times Cicero (De Div. II.) reasoned with sound judgment against the belief in astrology. The Emperor Vespasian, when told that his courtiers were discussing the prodigy of the appearance of a comet, said: "This *hairy* star does not concern me, it menaces rather the King of the Parthians for he is *hairy*, but I am *bald*." Similarly Henry IV. of France, speaking of the astrologers who had foretold his death, is said to have exclaimed: "They will be right some day, and

the public will remember the one prediction that has come true better than all the rest that have proved false." Bayle has well said: "The more we study man the more it appears that pride is his ruling passion, and that he affects grandeur even in his misery. Mean and perishable creature that he is, he has been able to persuade himself that he cannot die without disturbing the course of Nature and obliging the heavens to put themselves to fresh expense to light his funeral pomp. Foolish and ridiculous vanity! If we had a just idea of the universe we should soon comprehend that the death or birth of a prince is so insignificant a matter compared to the whole of Nature that it is not an event to stir the heavens."

Yet other writers from time to time allude to the fancies of the astrologers, and though it seems wonderful how so extraordinary a mass of unsupported conjectures and absurd notions can ever have been seriously regarded as science, still we must not look upon the work of these early zealots as altogether vain and wasted.

Just as the fruitless search for the elixir of life and the philosopher's stone by the old alchemists (themselves often astrologers also) laid the foundations of the modern science of chemistry, so by the watchings of the early astrologers was accumulated the material whereon their successors have built the mighty superstructure of modern astronomy. Though it is, and probably will remain, far beyond our power to predict the future course of human affairs, yet the astronomer can determine the future positions of the planets of our system for many ages to come with a precision greater than that of many actual observations. Halley's comet, whose return we have just witnessed, has been detected almost in the position assigned by calculation, after an absence of seventy-four years (of invisibility), during which time it has receded to a distance of more than three thousand millions of miles from the sun. The past and future history of the earth's path round the sun is known for a million of years on either side of the present time. From the observations of the early Chaldean astrologers, and their records of eclipses, the theory of the moon's motion has been, and is being, perfected.

So long as the earth was regarded as the centre of the Universe, and the sun and stars merely secondary orbs of no great size moving round it, there seemed little to wonder at in men's faith in the teachings of astrology, though even then one might ask how the special influences assigned to the various heavenly bodies, were ascertained to belong to them with such minuteness.

If a man's future career depended only on the position of the heavenly bodies at the time and place of his birth, how did it happen that of two persons both born at the same time and place, one became a beggar the other a monarch? How different, for instance, the careers of the twin brothers Jacob and Esau, and how different their temperaments! When we consider the earth as it really is, a small planet moving round its central sun together with its fellows, some approaching it in size, others greatly surpassing it, and that there have since been discovered two great planets and a number of moons quite unknown to the early astrologers, it seems hard to conceive our planet to be of such importance that all these other bodies merely exist for its benefit or, rather, for that of its inhabitants. Our sun, too, though all important to us, is only a "cadet" amongst the host of heaven, and there are stars probably as far surpassing it in magnitude as itself surpasses the earth.

Great Magnetic Storms.

By FRANK C. DENNETT.

FROM time to time much of the intercourse carried on by means of the telegraph is stopped, and the public learns that a magnetic storm is in progress. Then for a little the newspapers are filled with wonderful articles, mostly imaginative, and the reader is left little, if any, the wiser. A notable case occurred on Saturday, September 25, when, at five minutes after noon, the telegraphic instruments suddenly became unusable from earth currents which deflected their needles. This was the state of affairs for some hours. These storms are not local, but world-wide in their effects. It is noticed that the ordinary overhead telegraph is the form most sensitive, whilst telephones remain little affected. In

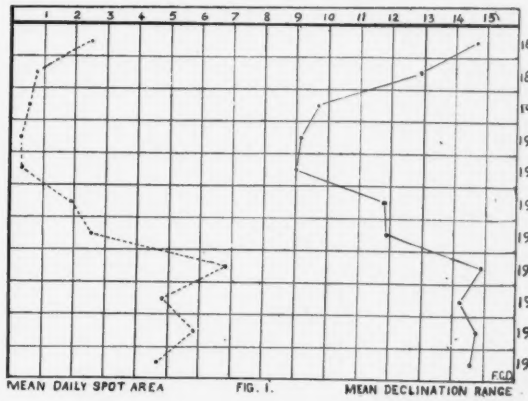


FIG. 1.

Fig. 2.—Sept. 25, 1909. $2^h\ 15^m$ to $2\ 30^m$.

Fig. 3.—Sept. 26.

the great storm of October 31, 1903, the electric tram service at Geneva was said to have been held up, but on this occasion no similar news has come to hand.

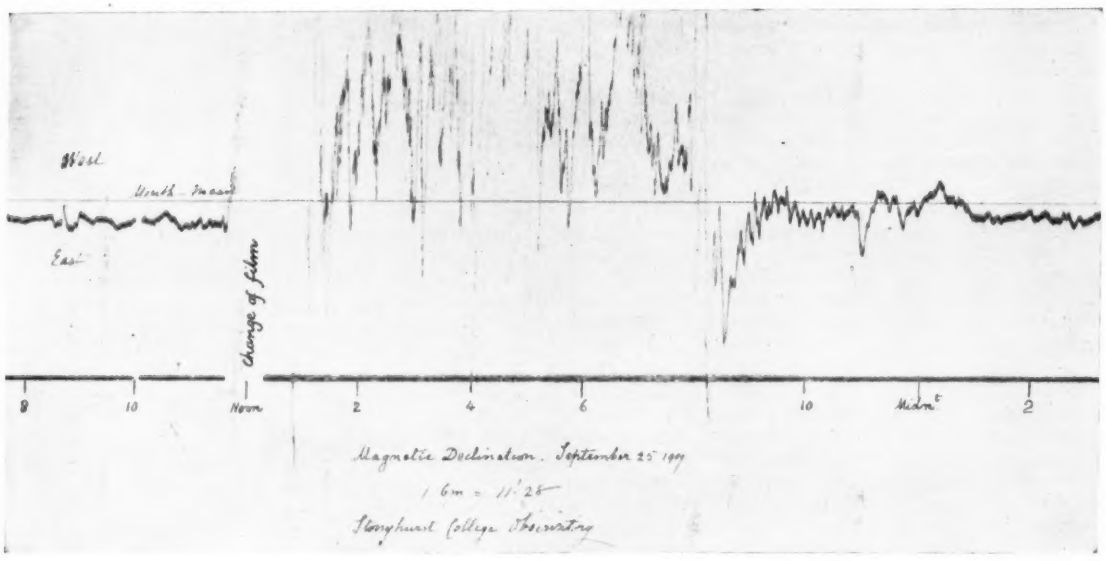
During the occurrence of these storms the needles at the magnetic observatories become greatly agitated, and the normal record, almost a straight line, is interrupted by a series of great swings to and fro. By the kindness of Rev. Walter Sidgreaves, S.J., Director of Stonyhurst College Observatory, we are enabled to reproduce the record of the present storm. This shows that there was a premonitory disturbance soon after 8 a.m., the needles not quite recovering their steadiness afterwards. The film was changed at 11.40 a.m. The new film commences by showing a considerable deflection to east, but very soon the deflection became westward and remained so until not far from 8 p.m., when, after a couple of swings from west to east of enormous magnitude, the deflections gradually decreased and became nearly normal a little before 4 a.m. At Stonyhurst it was considered that the total amount of deflection must have been $2°\frac{3}{4}$. At South Kensington between "8.7 and 8.22 p.m. a westerly movement of 98′" was "followed by an easterly movement of 84′,"

according to Dr. Chree in *Nature*. The oscillations were as rapid as in the great storm of October 31, 1903. As is usual when these magnetic disturbances occur, the Aurora became visible. In the early evening of the 25th it was seen in many places both in the northern and southern hemispheres. At South Kensington the spectroscope indicated its presence by the characteristic line even when the sky was clouded over.

That the source of the disturbance is to be sought in the sun there seems to be little doubt. Whenever these great storms occur there is apparently always a considerable spot on the sun. Yet it must not be forgotten that the late Lord Kelvin discredited the theory, considering that the tremendous energy necessary to produce such an effect, exercised at the distance of the sun, rendered such an idea untenable. Perhaps it will be as well to look at a little of the evidence in favour. It is pretty generally acknowledged that in some way there is a relationship between the earth's magnetism and the amount of spot-area upon the sun. The diagram (Fig. 1), showing the records from Stonyhurst College Observatory, 1898-1908, indicates the existence of such a relationship. The amount of mean daily spot-area is set down in units of 1/5,000ths of the visible disc, and the declination range is set down in minutes of arc. Yet this is a general relationship, whilst we are rather concerned with the particular connection.

Over and over we have been told of the observations of Messrs. Carrington and Hodgson on September 1, 1859. Both observers saw two brilliant spots of light, in a large spot group of considerable activity, not far from the sun's central meridian, travel rapidly along a short arc. During the five minutes between 11.18 and 11.23 a.m. they accomplished a journey of 35,000 miles and disappeared. At Greenwich Observatory "a sudden 'wave' took place almost exactly synchronous with the observations of Carrington and Hodgson (the amplitude of the wave being more than 10′ in declination and equally marked in H. F., though less so in V. F.), approximately 11.20 a.m. on September 1, 1859. The great storm is shown commencing between 4.30 and 4.45 a.m. on September 2." These particulars have been kindly supplied by the Astronomer Royal*. Here we get the three facts that there was a considerable spot disturbance, in a state of great activity, and near the central meridian. Rev. F. Howlett drew it, near the limb, on August 25. These three facts seem to recur with every considerable magnetic disturbance where particulars are available. The active spot usually has passed the central meridian, often about forty-five hours before the great storm takes place, as was pointed out by M. Riccò in writing of the "Sunspots and Magnetic Perturbations in 1892."

In the present instance the big spot reached the central meridian at 2.38 p.m. on 23rd, the great outbreak occurring just over 45 hours later. The spot had been very active as it advanced on the disc. At 12.20 p.m. on 24th Professor A. Fowler, of the Imperial College of Science and Technology, South Kensington, observed a brilliant reversal of the C line over one of the umbræ, caused by a very bright overlying pro-



The reproduction is a reduction from the original photograph on a scale as 8:15.

minence. On 25th, about 11.30 a.m., Mr. E. A. Holmes found C superlatively brilliant over two of the umbræ, and larger than the umbræ. On 25th, at 9 a.m., the writer noted that the spot had apparently grown, but at 1.30 p.m. it had assumed a spiral form, which was drawn by Mr. E. E. Peacock at 2.15 to 2.30 p.m. as in Fig. 2. On 26th the same pencil drew it as in Fig. 3. Here, then, we have a very active spot, of considerable size, a little past the central meridian. A spot of very similar size, yet of much less activity, reached the central meridian about 9.30 a.m. on October 4 which caused but a small amount of disturbance. On May 13, 1909, a spot reached the central meridian about 2.30 p.m. Some time between 9 a.m. and 3.30 p.m. it had assumed the strong spiral character. On the same day a magnetic disturbance occurred sufficient to be described as "very great" at Stonyhurst and lasted into the next day. There is another equally considerable disturbance recorded on May 18, but on this occasion a smaller group of elliptical form was breaking out in the

* The verification was sought by the writer owing to a note, which is apparently based on a mistake, occurring on p. 43 of Sir R. S. Ball's "Story of the Heavens," edition 1905.

northern hemisphere close to the central line. Recent work at Mount Wilson, Meudon, and Chicago has shown that the great and active spots are the seat of cyclonic action on an immense scale; the polariscope as well as the telescope and spectroscope all confirm the rotation. The more powerful spectroscopes also have shown the duplication of some spectral lines over the active spots known as the Zeeman effect. This effect is produced by the light passing through a powerful magnetic field. Hence we know that when dealing with these vortices we are, in fact, dealing with seats of great magnetic force. It is an acknowledged fact that such would have a more powerful action earthwards when situated near the apparent centre of the disc. Here, then, there seems additional proof that the disturbances are the real outcome of the solar storms. Lockyer and Tacchini have considered the prominences rather than the spots as being related to the disturbances. But it appears to be rather the gigantic vortex which is the cause of the spots and prominences to which we should give attention. In comparing the spot passage over the meridian with the terrestrial magnetic storms one point should not be lost sight of. The lists usually give the longitude of the front extremity of a spot group, but the great disturbances are usually at the rear of the large spot, and, further, the great prominences seem to be very rich in helium, which apparently indicates the presence of radium. The radiations appear not to be broadcast, but, rather, in beams, whether like the coronal beams we see at a total solar eclipse or not cannot be answered yet. Mr. Maunder and others have pointed out that if there be magnetic disturbance of a pronounced character a second edition may be expected, though not necessarily of so great strength, 27 days later, when the same solar meridian is central. Mr. Buss has also shown that there is usually a lesser disturbance midway between the two greater ones.

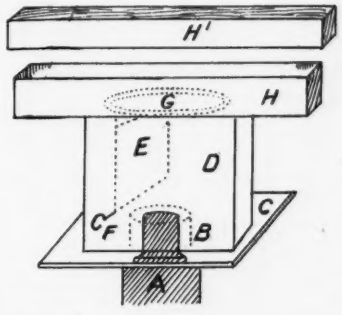
From the variations which occurred in Moorhouse's Comet a year ago, some of them certainly synchronising with solar disturbances, notably on September 30, it appears that it is necessary to study these phenomena in unison. The fact one desires to know is whether these vortices on the sun are the cause of the disturbances, or whether the cause is to be looked for outside of the sun. There is evidence both ways, but to the writer it seems that the real seat is to be found in the cyclonic storm, which sets up a gigantic and powerful magnetic field.

ARRANGEMENTS are being perfected in New York for the incorporation of the American Radium Institute, to be devoted to the treatment of cancer and similar diseases. The institute will be conducted much on the same plan as similar ones in Paris and London. The work will be divided into various sections, such as chemical, physical, medical, and botanical, with an expert in charge, and it is believed that for experiments the laboratories of the Rockefeller Institute will be available. Supplies of pitchblende for manufacture are to be drawn from Colorado and other Western localities, where the initial processes of extracting the radium will be conducted. It is announced that the institute is not in any sense commercial and that several of the scientists who are interested in it are not only giving their services free, but are contributing from their own means to the fund which will be required to establish the plant.

A Cheap Micro-camera and What It Can Do.

By BERNARD THOMAS, M.B., C.M.

MANY readers of "KNOWLEDGE," who are students of the microscope, would no doubt be glad to have permanent records of what they see, and for this purpose I wish to describe a camera which any one can make at a nominal cost out of simple material. What is wanted is a cardboard box about 4 ins. square, a pill-box or round match-box with the ends knocked out, that will surround the top of the eyepiece of a microscope, an empty quarter-plate box, some strong wire, cardboard, black cloth or black paper, and plenty of paste. The camera, if it can be so called, is a dark box, the eyepiece of the microscope acting as lens. A round hole is cut at the bottom of the open box and on the inside of it is fastened the rim of the pill or match box. Level with the top of this and with a bend like this ⌒ in the middle, a piece of stiff wire is passed through the box, the wire outside being fashioned into a handle. Over the bend in the centre of the wire a piece of stiff card is fastened. This drops over the eyepiece forming a lid, or it can be moved away and



A, Microscope eye-piece; B, "Pill-box" rim for eye-piece; C, Thick cardboard support; D, Dark box; E, Flap shutter; F, Handle for shutter; G, Hole through plate carrier; H, Plate carrier; H¹, Lid.

will drop back against the side of the box. To the open end of the box is pasted an open quarter-plate box the bottom of which has been cut out to form a rim to admit the image. Now it is all ready and only wants two or three thicknesses of black cloth or black paper pasted on it, care being taken that it is sufficiently light-proof.

To take a photo. the camera is placed on the eyepiece of the microscope, which must be upright. A piece of ground-glass placed on the plate box makes an excellent focussing screen. When, with careful adjustment, the image seems to be clearly defined, the box is removed from the microscope to the dark-room, the plate introduced, and the shutter and lid closed. A piece of cardboard covered with black cloth the size of a quarter-plate and placed over it is an extra precaution. The camera is again fitted on the microscope, the photo. exposed, and then the remaining development done in the dark-room. Certain points are worthy of note. First, when viewing with the ground-glass the light may be screened by a cloth-covered funnel. Next, it is important to see that the adjustment of the microscope is sufficiently firm and not liable to be altered by the weight of the camera. Lastly, the camera must be steady, and to this end remove the eyepiece and have a

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Fig. 1.—Transverse section of Rhizome of Pteris.

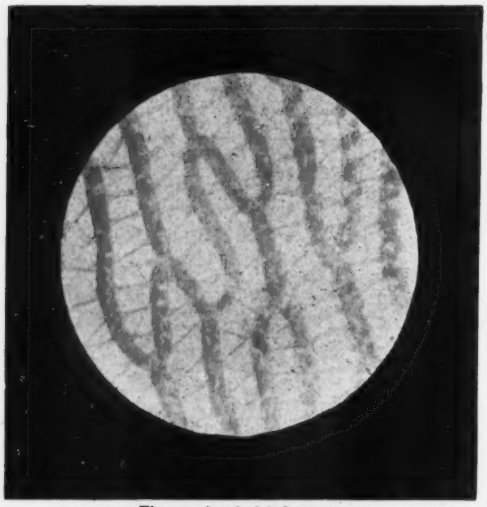

Fig. 2.—Leaf of Sphagnum.

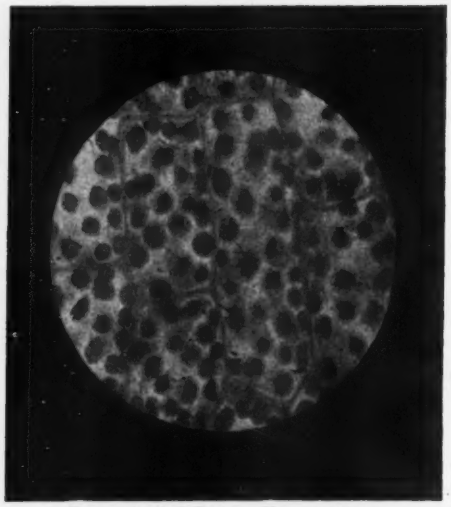

Fig. 3.—Leaf of Funare Hygrometrica.

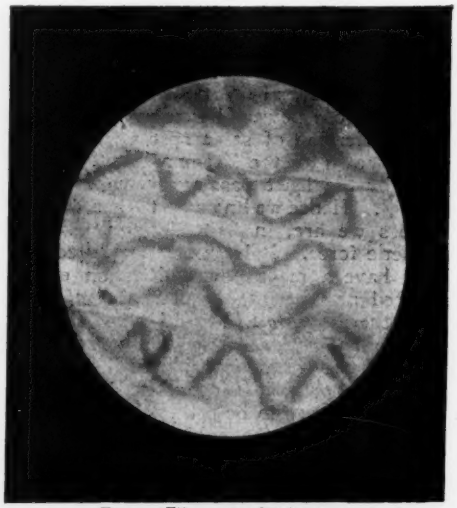

Fig. 4.—Filaments of Spirogyra.

Fig. 5.—Gammarus.

Fig. 6.—Hydatina senta feeding on Desmids (*Closteria*).

piece of stiff cardboard with a round hole in the middle which fits the microscope end of the eyepiece, and so, placing it in the tube, you have a platform on which the camera can rest. The diagram will, perhaps, explain better than any written description.

I have taken several photos. with this little camera, and the few presently to be described will give an idea what can be done. I showed this little camera and some photos. to the Chief Health Officer of Tasmania (Dr. Elkington), who is much interested in microscopic work. He was so pleased with it that he made one for himself. I believe he told his ministerial chief that he had made an addition to his department and installed a micro-camera for his work. He hoped the Government would sanction the expense. The Minister was agreeably surprised when he found the item to be just 4½d.

With regard to the photographs.

Fig. 1 will no doubt be identified as a transverse section of the rhizome of the common bracken (*Pteris*). A fibrovascular bundle is well seen amongst the parenchymatous cells. Taken with a 1-in. objective exposure (in daylight) a few seconds.

Fig. 2.—Leaf of the bog-moss (*Sphagnum*). Here the interesting arrangement of the large transparent hooped cells surrounded by the smaller and narrower chlorophyll-containing cells is well seen. At the lower part of the photo. one of these "hooped" cells is seen with a hole in it. This is taken with a dry $\frac{1}{10}$-in.; the exposure, consequently, is much longer, about a minute and a half.

Fig. 3.—Leaf of a common moss (*Funarea hygrometrica*). The cells are lined with chlorophyll corpuscles. This also is taken with $\frac{1}{10}$-in. objective.

Fig. 4.—Taken under the same conditions will be easily identified as Spirogyra with the lovely green spiral bands.

Fig. 5.—The head and forepart of Gammarus, the fresh-water shrimp. One-inch objective and exposure about ten seconds.

Fig. 6.—Although, owing to unavoidable causes, not quite clear, is of interest, because it shows a rotifer (*Hydatina senta*) in the act of enjoying a good meal of Closteria, one of which can clearly be seen in its jaws. Of course, its somewhat indistinct outline is due to movement.

Several other micro-photographs might be shown, but I have already encroached too much on the space of your interesting paper. I would like to add that all the photos. were taken on special rapid quarter-plates (Imperial) and developed with M.Q. tabloids.

The Highest Human Ascent.

IT has been stated that a new Italian record of 38,700 feet has been created in Italy; but according to a letter from the aeronauts themselves, Messrs. Mina and Placenza, it appears that the maximum height was only about 9,200 metres, or 30,180 feet. Since their cotton balloon held only 80,500 cubic feet and contained illuminating gas, this was a remarkable performance; and though there is some doubt as to the barometric observations, it probably exceeds both the French and Italian records. The world's record is, however, still held by Messrs. Berson and Süring, who ascended from Charlottenburg, near Berlin, on July 31, 1901, in a balloon of nearly 300,000 cubic feet capacity partially filled with hydrogen gas, to the height of 34,450 feet.

German Museum of Master-Pieces of Science and Industry.

(By Our Berlin Correspondent.)

BOTH England and France have long been in possession of a museum illustrating the evolution of science and industry and the mutual influences between engineering, scientific research work, and commerce and trade. The Conservatoire des Arts et Métiers of Paris (founded at the end of the eighteenth century), besides representing the significance of technical achievements in their relation to the factors above mentioned, is intended to propagate technical knowledge by the aid of popular lectures. The collections of the Kensington Museum (established toward the middle of the nineteenth century), on the other hand, afford a comprehensive idea of the gigantic strides made by England in the field of mechanical engineering, without there being any more intimate connection between this part of the Museum and its mathematical and scientific departments.

The German Museum of Masterpieces of Science and Industry, which was inaugurated a short time ago, is intended to become a national German institution of a similar kind, a special point, however, being made of the mutual influences of science and engineering. Apart from retrospective exhibits, the very latest achievements in the field of technical and scientific investigations were to be represented. Besides serving as a Pantheon to those men whose thought and work have been operative in fashioning modern civilisation, this Museum was thus to become a source of historical knowledge to the scientist, and a place to which both engineers and laymen could refer for fertile ideals and models.

As the Bavarian Academy of Sciences as far back as 20 years ago had made plans for extending its mathematical and physical collections on strictly historical lines, many useful instruments and apparatus of historical importance were already at the disposal of the founders of the new museum. The latter was inaugurated a few years ago (on June 28, 1903) in provisional headquarters, the State having placed at its disposal the rooms of the old National Museum in Maximilianstrasse. As, however, these in the following years proved inadequate, an extension was granted in the Department of War, which at the beginning of 1905 ordered some collections of the museum to be installed in the Isar Barracks. The foundation stone of the definite building was finally laid a few months ago by the German Emperor. The museum comprises:—

1. Collections of scientific instruments and apparatus as well as of remarkable technical products (both originals and models). These collections are well classified and provided with necessary information for the benefit of the visiting public.

2. Archives containing important documents, both scientific and technical.

3. A technical and scientific library, containing manuscripts, diagrams, pamphlets, and books.

In order to preserve the memory of prominent workers in the field of engineering science, portraits and biographies of those Germans whose labour has been especially noteworthy in furthering the evolution of industry will likewise be incorporated with the museum.

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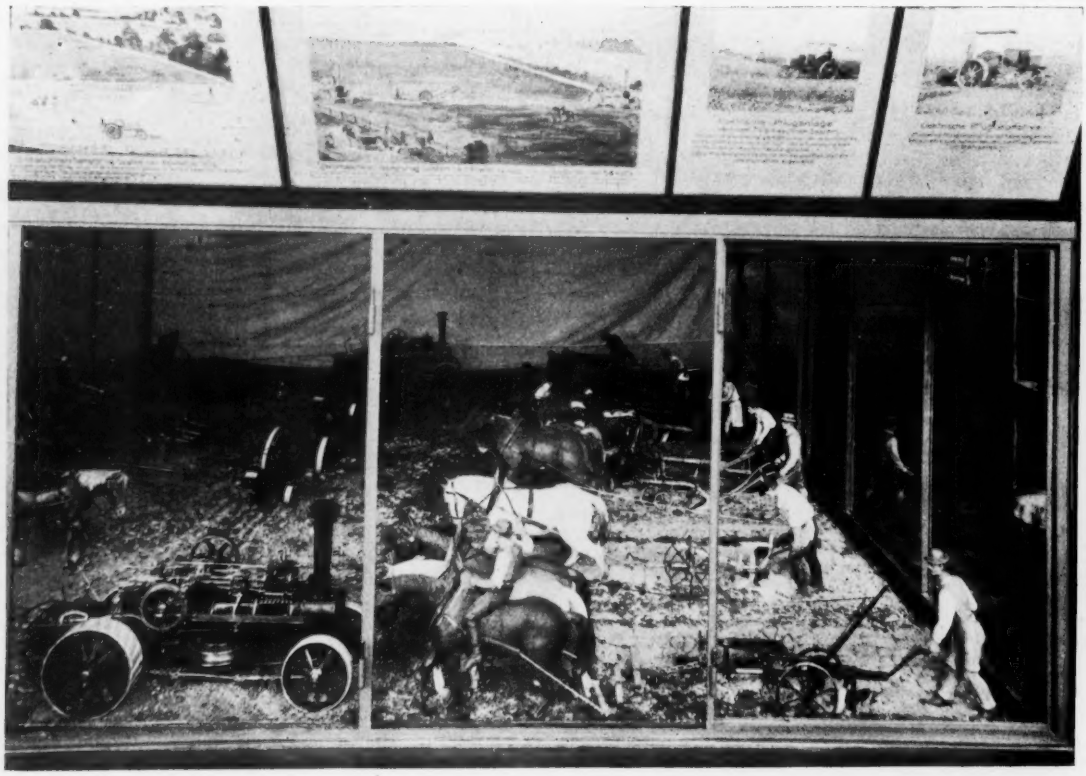
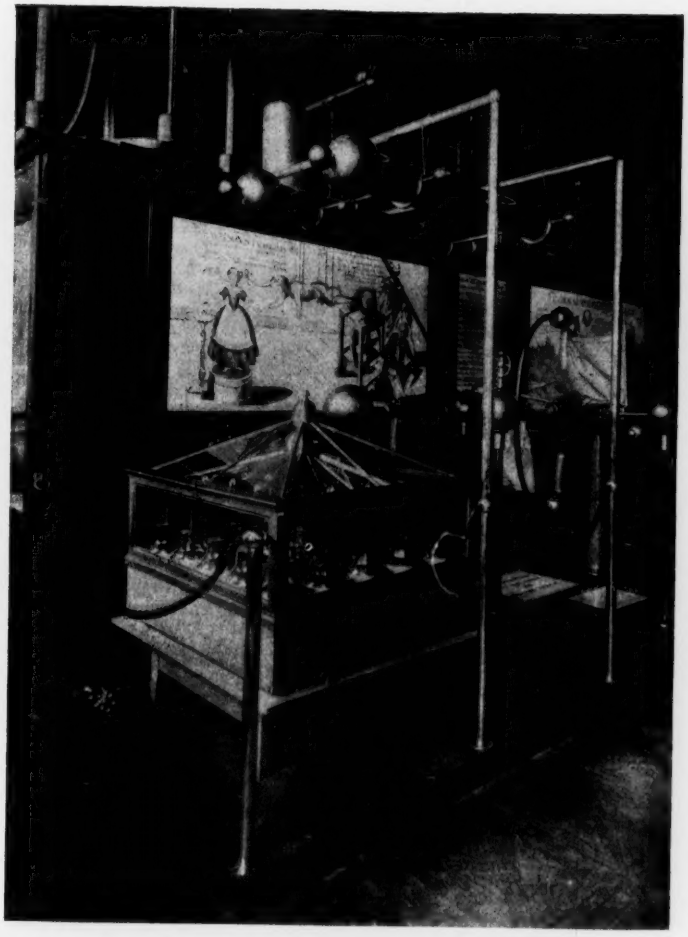


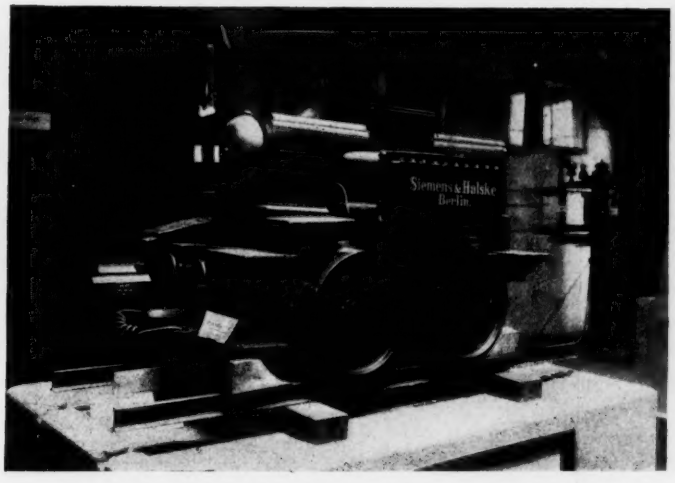
Model field demonstrating evolution of the plough. To the left, a motor plough of the double-engine system.

Set of rock drills, comprising the first solenoid drill designed by Siemens (1879). From the "Mining Department."

THE GERMAN "SOUTH KENSINGTON MUSEUM."



From the "Friction and Contact Electricity Department."
Electric machine used by G. S. Ohm, with battery of Leyden jars



From the "Roads, Metropolitan and Electric Railways Department."
(Original of first electrical locomotive by Werner Siemens (1879

In carrying out the task laid before the museum—to illustrate the evolution of any fundamental ideas and the influence of such ideas on the various economical factors, as well as to represent the ideal success of acquired knowledge and the importance of past experience—the most various methods and means had to be resorted to. In fact, many fields, which apparently are strictly separated from each other, had to be classified and combined together, in order to afford an adequate picture of civilisation as an offspring of science and engineering. The historical aims of the museum are mainly realised by original machines and apparatus, in addition to the records of the very first experiments in a given direction, and the earliest sketches and designs. These collections, in order to illustrate the achievements of science and industry in a really comprehensive manner, necessarily had to be international.

The technical and scientific library referred to, which is intended for serving the scientific purposes of the museum, contains both ancient and modern works, pamphlets, periodical publications, etc., on subjects of engineering, mathematics, and science. While furthering historical investigation this library is intended to make accessible to both specialists and lay people the very latest scientific and industrial achievements. The archives of maps and diagrams of unsurpassed dimensions is connected with the library, and will allow both the engineer and workman to obtain useful information on subjects otherwise inaccessible. While the collection of documents and manuscripts is of mainly historical interest, it should be remembered that the museum, so far from being merely an archive of things of the past, is meant to be primarily an organisation operating to further scientific research and popularise technical knowledge. This will be best understood from the accompanying illustrations, representing a few examples of the most extensive collections of the museum. One of the cases shows a model of the "Saint Maria," in which Columbus discovered America. The interior of an alchemistic laboratory forms part of another exhibit and will be found especially instructive, as compared with the examples of chemical laboratories in the eighteenth, nineteenth, and twentieth centuries. While on one hand a most striking progress from the primitive apparatus of alchemists to the improved instruments of modern chemists will be noted, it is interesting to observe that certain apparatus still retain their original traditional form in which they have been used by the predecessors of present-day chemists. The evolution of ploughs is figured from the most primitive implement, viz., roughly-shaped trees drawn first by men and afterwards by oxen, to the present-day steam ploughs, passing through many stages which had to be traversed in various ages and centuries. Another feature in evolu-

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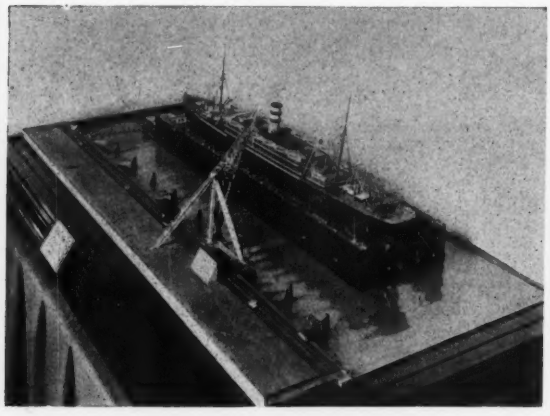
tion pertains to the development of automobiles, from the first motor-car constructed by Daimler in 1885, to the most improved modern types. In the same hall will be found a similar restrospective exhibition, relating to the various stages in the evolution of cycles.



From the "Nautical Department."
Model of iron floating docks, by Blohm and Voss.

The strides made in a special branch of railway engineering, viz., the construction of mountain railway locomotives, are graphically rendered. Side by side with the latest type of locomotive used on the Rigi railway is a model of the earliest type used on the same railway line, the latter having been constructed in 1871.

CORRESPONDENCE.

Model of the Solar System.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—I was much interested to read in this month's number of "KNOWLEDGE" Miss Agnes Fry's account of her Model of the Solar System, having some years ago set up a somewhat similar arrangement in my garden, situated in the upper part of Hythe. The adopted scale is the same, viz., one million miles to one foot. The available space, however, only allowed the inclusion of the four nearest planets, but the position of the more distant ones may be spotted on certain conspicuous objects at proportional distances in the country below, which are visible from the model sun.

In my model the Sun is represented by a hollow copper ball, 10¼ in. diameter, and gilded; it is attached to the flag-pole, about 15 feet from the ground; around it are placed the planets Mercury, Venus, Earth, with Moon, and Mars, at distances according to the above scale. The model sun being observable from each. The planets are represented by lead shots selected as nearly as possible to the same scale and coloured white, each being suspended by a fine hair under a small glass shade supported on a disc at the top of a piece of gas pipe rising about 3 ft. from the ground. The Earth and Moon, being only three inches apart, are suspended under one shade, which can be turned on its axis as a ready means of explaining eclipses, etc.

Your correspondent's observations are most interesting and instructive. I think that if such models could be arranged on some of our public spaces (suitably protected and with an explanatory label at each of the planets) they would form a very instructive object-lesson, appealing to the general observer as well as to those interested in astronomical science, and would be especially useful for educational purposes.

Yours, etc.,
JAMES B. JORDAN.

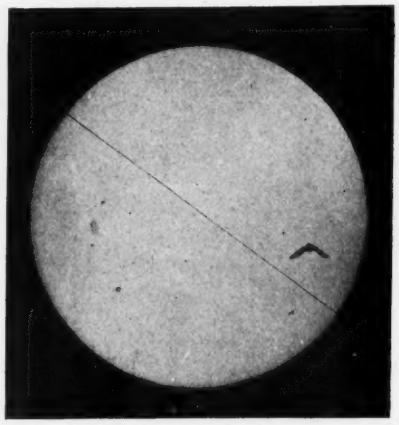
"Hayfield,"
Hythe, Kent.
November 15, 1909.

A Curious Photograph of the Sun.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—The accompanying illustration is a photograph of the sun taken with the the 12-inch equatorial of the Yerkes Observatory, October 28, 1909, at 2h. 11m. central standard time.

It is the custom to project the sun, by means of the 3-inch finder, upon a sheet of white paper, to watch for a moment of good seeing for the exposure with the 12-inch. While this was being done, the bird, probably a crow



(*Cornus americanus*), appeared on the image, and the exposure was instantly made, with the above result. At first glance one might think the picture inserted, but the orientation of the plate shows that the wings were on the down stroke when the exposure was made.

The fine black line is made by a wire in the plate-holder to give the east and west direction. The two small black spots on the left are sun-spots.

Yours, etc.,
FREDERICK SLOCUM.

Yerkes Observatory,
The University of Chicago,
Williams Bay, Wis.
November 8, 1909.

An Old Lunar Influence—A Theory.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—It is a remarkable modern discovery that in the Carboniferous Age coal plants flourished even in what are now the Arctic regions. Evidence of a like nature may yet be gleaned from Antarctic areas.

How may these former tropical or sub-tropical conditions be accounted for? Perhaps at that immensely remote period, the Moon had not then parted with all its sensible heat. These dark rays may have been sufficient to affect the atmosphere of the earth and thus favour tropical conditions at or near to the Poles.

Perhaps physicists will supply data for or against this theory.

Yours, etc.,
E. RATTENBURY HODGES.

"*Waltair*,"
Tavistock, South Devon.
October 27, 1909.

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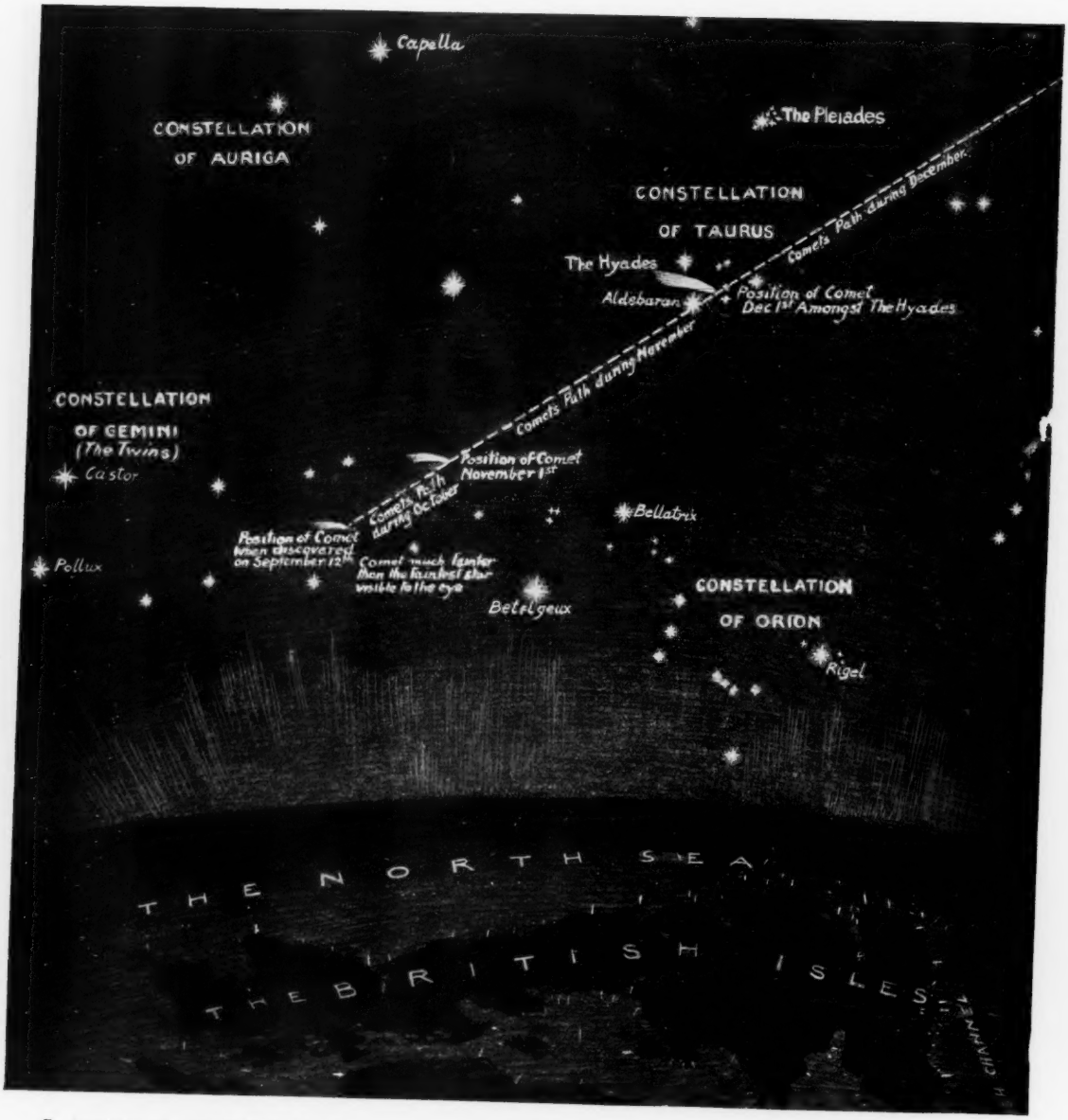

By permission of "The Daily Graphic."

The Path of Halley's Comet among the Constellations during December.

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Great Events in the World During Apparitions of Halley's Comet.

By IRENE E. TOYE WARNER.

PERHAPS the chief reason for the fascination which Halley's comet undoubtedly exercises over professional and amateur astronomers alike lies in the fact that it has been actually *seen* by nations long since passed away; that when we look at the faint nebulous object just beginning to come within reach of our large telescopes we are observing the same "hairy star" which terrified and awed our ancestors. Other comets have appeared, some far more brilliant even than Halley's, and some few also have been known to be the same which former nations saw hundreds of years ago. But Halley's is very essentially historical and has a certain record going back to the year B.C. 87, and probably even to B.C. 467, though the identification of the latter apparition is doubtful.

The comet is justly named after Halley in recognition of his discovery of its true periodic nature. Until his time it was repeatedly observed, but never really known to be the *same* object returning to the sun at stated periods which can be fairly accurately calculated. Owing to the great amount of material and the vastness of the subject I can only glance at a few of the many events which this celebrated comet witnessed and for which, indeed, in early ages it was held responsible.

B.C. 467.—A comet was seen by the Chinese in the second year of the Emperor Ting Wang, which would be B.C. 467 (according to Messrs. Cowell and Crommelin), when Halley's comet should have been visible. Probably the comet noticed was a return of this celebrated visitor. There seems to have been no record whatever of the two preceding apparitions, so far as is at present known.

B.C. 240.—The Chinese seem to have again recorded the comet in this year, for in the Ma-tuan-lin it is stated: "In the seventh year of the reign of Che Hwang a comet first appeared in the east. It was afterwards seen in the north. In the fifth moon (May) it was seen for 16 days in the west."

At this time Egypt was ruled by Ptolemy III., Euergetes. The Romans were engaged in the First Punic War, which lasted 23 years; in 241 the battle of the Aegatian islands had been fought with the result that Carthage sued for peace and evacuated Sicily. The commerce of that celebrated city thus suffered a severe check. Carthage was still further exhausted in 240 by a general mutiny of her mercenary troops which had been employed in Sicily and were now to be disbanded. The ringleaders were Spendius (a runaway slave) and Matho, a Libyan. These desperate men led the troops to plunder the surrounding country. They then raised the Africans in rebellion, besieged the towns of Utica and Hippo, and cut off all communication by land with Carthage. The war was terminated by the skill of Hamilcar, who defeated Spendius and Matho. The struggle was called the "Inexpiable War." In 241 the young King of Sparta, Agis IV., was put to death, practically a martyr in the cause of reform, by Leonidas, but, strangely enough, a few years afterwards a son of the latter named Cleomenes succeeded in bringing about the very reforms for which Agis had died!

B.C. 163.—Of this return there is no record, though a very brilliant comet which came in 165 may have been Halley's. The Jews were engaged in war with Antiochus Epiphanes, King of Syria, who had enraged them by offering swines' flesh on the altar of Jehovah. Mattathias and his sons revolted in 168 and maintained a struggle for independence. In 164 Epiphanes died and his son Antiochus Eupator came to the throne, but was speedily ousted by Demetrius and murdered, the latter seizing the reins of government and continuing the war against Judas Maccabæus. In Egypt Ptolemy VI. was king.

B.C. 87.—When the comet came in 87 it found civil war raging in Rome. Marius, whose life was most romantic and full of adventure, had been chosen to supersede Sylla, but was outlawed by the Senate. After many thrilling adventures he landed in Africa, but soon returned to Italy, joined the Consul Cinna, and blockaded Rome, which he entered victoriously. He then took revenge on his former enemies and there was a general massacre, after which he became Consul for the seventh time. Towards the end of 87 Sylla besieged Athens and took it on March 1, 86. In the former year (87) he took Piræus and afterwards defeated Archelaus at Cheronæa and thus put an end to this attempt for the recovery of Grecian independence.

The Chinese tell us that "In the second year of the epoch How Yuen (87) the seventh moon (August) there was a comet in the east," but we do not know much about Chinese political events.

B.C. 11-12.—Dion Cassius refers to the appearance of a comet before the death of Agrippa, when Valerius Messala and Sulpicius Quirinus were Consuls. It seemed to them to be suspended over Rome. That this was an ancient apparition of Halley's comet is proved by the agreement of this observation with those of the Chinese. It traversed the constellations of Leo, Böotes, Hercules, Ophiuchus, and Scorpio, being lost in the sun's rays 56 days after its discovery.

A.D. 66.—It is a matter of discussion which of the two comets that appeared in 65 or early in 66 was Halley's. Both are mentioned in the Chinese annals. The first was discovered in Leo and was visible for 56 days, whilst the second was seen in Sagittarius and Scorpio and was visible for 50 days. One of them caused great terror to the Jews as it appeared to hang over the doomed city of Jerusalem before its capture and destruction by the Romans under Titus. In 66 the Jews revolted, in 67 Vespasian was sent to Judea by Nero, and in 70 Jerusalem was taken. In 66 Nero visited Greece and competed for the Olympic crown at the games, and the following year St. Peter is supposed to have been martyred, and Linus made Bishop of Jerusalem. It is interesting to think that St. Peter saw the comet at this momentous time in the history of the Christian Church. Perhaps St. Jude also refers to it when he says: "Wandering stars, for whom the blackness of darkness is reserved for ever."

A.D. 141.—The only comet recorded by the Chinese in this year agrees fairly well with the elements of Halley's. At this time the Romans practically ruled Britain and were continually fighting the Caledonians. The Roman Empire was under the Antonines.

A.D. 218.—In the Chinese catalogue of Ma-tuan-lin an account is given of the comet. It was also described by Dion Cassius as a very fearful star extending its tail from the west, eastwards. It passed through the constellations of Auriga, Gemini, Leo, and Virgo. The Emperor Macrinus died soon after its appearance, and Elagabalus (Heliogabalus) was made Emperor by the soldiers, the administration being in the hands of Julia Mæsa and Julia Soæmias, grandmother and mother of the Emperor. He brought to Rome the Syrian sun-worship, as he had been a priest of the sun-god.

A.D. 295.—The comet was seen in the "fourth

moon," when traversing Andromeda and Virgo. Diocletian, at this time, was re-organising the Roman Empire. He was a good pagan, whilst his successor, Constantine, was the first Christian Emperor.

A.D. 373.—The Chinese mention a comet as being visible in Ophiuchus near Alpha Ophiuchi and Alpha Herculis. About this time the Roman Empire was again divided, Valentinian being Emperor of the West, and Valens of the East. The former was fighting the Alemanni and other German invaders; and the kingdom of Hermanric rose in power and splendour.

A.D. 451.—Halley's comet was seen in this year by Chinese and Europeans; the former discovered it on May 17 and followed its course through Taurus, Leo, and Virgo until the middle of July. At this time affairs in Europe were in a most critical condition. In 450 Marcian refused to pay tribute to the Huns, in consequence of which their renowned leader, Attila, in 451 invaded Italy, but was defeated at Châlons, a town in the N.E. of France, by the Roman General, Aëtius, who had organised a great confederacy with the west Goths and Franks for this purpose.

It is difficult to realise fully the importance of this battle. It was literally a fight between Christianity and heathendom, for had Attila conquered, humanly speaking, the progress of the former would have been arrested for a number of years. This battle was also memorable for being the last important victory gained by Imperial Rome. It was, indeed, a fitting termination to her long and glorious career. Attila died in 453, and after his death the Hunnish Empire collapsed. Attila's fame has come down to us in the Sagas of Norway and Iceland, and in the most ancient German poetry. In the latter Etsel (Attila) is described as "the wearer of 12 mighty crowns, and as promising to his bride the lands of 30 kings whom his irresistible sword has subdued" (Creasy). He regarded himself as "the Scourge of God" and His instrument to punish the decadent Romans. In the same year England was invaded by Jutes, who made a permanent settlement in Kent, Hampshire, and the Isle of Wight, after they had defeated the Picts for the Britons.

A.D. 530.—About this time Saxon invaders founded a kingdom which included Middlesex and Essex, with London for its capital. We might say that Halley's is particularly our national comet ever associated with our triumph and advancement, bringing us prosperity (so to speak), but the very reverse to the French. In this year Belisarius subdued the Persians and suppressed the riots.

A.D. 607.—The Persians invaded Asia Minor, then a Roman Province, and the Emperor of Constantinople was continually engaged in keeping back their armies. In England Ethelbert extended his rule to the Irish Sea.

A.D. 684.—The Mohammedan Arabs attacked the Roman Empire of the East and in a few years conquered Syria, Egypt, and Africa. The comet was observed in Japan and China.

A.D. 760.—It was well seen in China and Europe in the 20th year of the Emperor Constantine. At that time Angus Macfergus, the greatest Pictish King of Scotland, was at the height of his power, and in England, Mercia, under King Offa, was head of the kingdoms.

A.D. 837.—The comet was seen in China and Europe. Some thought it was a warning of the death of Louis le Debonnaire. The Danes were ravaging the coastlands of Britain and France, and were the terror of Western Europe. King Egbert of England died in 836 and was succeeded by his son Ethelwolf, who could not check their rapid incursions, and finally they settled in England.

A.D. 912.—We have no record of this return, but calculation shows that Halley's comet must have appeared about the date mentioned. In England Edward, son of Alfred, was King, though his claim was disputed for some time by his cousin Ethelwald. Duke Rollo, the Northman, had obtained Neustria from the French King, and named it Normandy after his Scandinavian warriors. When the comet came they were firmly settled in that country from which they were to conquer England when it returned in 1066. Rollo professed Christianity and married the daughter of the French Duke Robert, thus consolidating his power in the new country until his successors should be able to seek "fresh woods and pastures new."

A.D. 989.—In England Ethelred the Unready ruled. He was continually struggling with the Danes, whom he tried to buy off, of course, without success, the end being that in 1013 Sweyn, King of Denmark, was proclaimed King of England.

A.D. 1066.—In our history there is no date, perhaps, of greater importance than this, for England, after William's conquest, became a power not to be despised in the affairs of Europe. Gibbon says: "Assuredly England was a gainer by the Conquest," and Rapin that it was "the first step by which England has arrived to that height of grandeur and glory we behold it in at present." In 1066 there were *three* competitors for the crown of England—first, Harald Hardrada, King of Norway; second, Duke William of Normandy; and third, Harold of England, the national hero. Harold fought the Norwegians at Stamford Bridge (September 25, 1066) and defeated them, and then with a tired army was compelled to hurry south to meet William of Normandy, who had landed at Pevensey on September 29.

Harold was thus forced to resist two invasions conducted by experienced generals in command of picked soldiers, and it seemed as if England must become either a dependency of Normandy or Norway. Brave and clever though he was, the task was beyond his strength, for all Europe at the command of the Pope were on the side of William, and, to crown all, a comet of great brilliancy was noticed and was popularly supposed to herald William's victory. It is represented on the celebrated Bayeux tapestry and has now been proved to be a return of Halley's comet. It is reported to have been equal to the full moon in size, and its tail, at first short, increased to a wonderful length and struck terror into the hearts of the people. The conditions under which the comet was visible in 1066 are something like those predicted for that we are now about to witness, so possibly we may have a brilliant spectacle. A vivid and most interesting description of the memorable battle of Hastings will be found in "Fifteen Decisive Battles of the World," by Creasy. William was the last to conquer this country, though Dutch, Spanish, and French have made the attempt. Thus Rollo obtained Normandy at one apparition, and William England at another.

In 1066 there was a famine in Egypt which lasted seven years and was the worst known in mediæval times.

A.D. 1145.—At this time Europe was preparing for the second Crusade, which commenced in 1146. In England there was civil war between Stephen and Maud, which ended in the triumph of the former. The comet is mentioned as being visible a long time and very brilliant.

A.D. 1222.—When Halley's comet appeared in this year Henry III. was King of England, and the barons

gained great power, the King being too weak to check them. El-Kamil, son of Adil, ruled Egypt at this time. He improved irrigation, completed the citadel of Cairo, founded colleges, and encouraged learning. St. Francis of Assisi preached before him, and he was generous to Christians until the crusade of St. Louis revived the old enmity. The comet's revolution period for this return, 1222 to 1301, is the longest on record, being 79 years 2 months, whilst the round now being accomplished is the shortest, lasting only 74 years 5½ months.

A.D. 1301.—At about this date an ambitious Pope, Boniface VIII., changed the papal biretta to the double tiara, denoting the supremacy of the world. He also opposed the imperialism of France by advancing "those pontifical claims which had already raised the Papacy above the Empire." Despots began to grasp the free cities of Italy. The Ottomans founded their Empire, they took Hadrianopolis, the Greek Emperor became a vassal to them, and they were only prevented from attacking Constantinople by the approach of Timur. Civil war raged between Cantacuzenus and the Palæolgi. Edward I., one of England's greatest kings, was about to fight the Scotch under Sir William Wallace, and had already made Wales a dependency of the English crown.

A.D. 1378.—Richard II. was King of England and John Wiclif was nearing the close of his life after translating the Bible into English and thus aiding the Reformation which came later. In this year there were schisms in the Papacy. The comet was seen in Europe and China.

A.D. 1456.—When Halley's comet came in great splendour in this year the English were engaged in civil war—the Wars of the Roses—and Henry VI., after being taken prisoner in 1455, was then released for a time. Affairs in Europe were extremely critical, and the fate of Christendom hung in the balance. Constantinople had been captured by the Turks under Mohammed II. in 1453, and after this the Crescent seemed likely to carry all before it. Pope Calixtus III. issued a Crusade Bull on May 15, 1455, and urged the Christian leaders to unite against the common foe. There is an erroneous impression connected with this celebrated Bull that Calixtus III. exorcised the *comet*. The idea originated most probably from a passage in Platina's *Vitæ Pontificum*, "A hairy and fiery comet having then made its appearance for several days; as the mathematicians declared that there would follow a grievous pestilence, dearth, and some great calamity, Calixtus, to avert the wrath of God, ordered supplications that if evil were impending for the human race He would turn all upon the Turks. He likewise ordered to move God by continual entreaty that notice should be given by the bells to all the faithful at midday to aid by their prayers those engaged in battle with the Turks." Belgrade was invested in June, 1456, and was just saved from capitulation by the timely arrival of the Christian army under Hunyadi, Capistrano, and the papal legate Carvajal. They broke the barrier of Turkish ships after a five hours' conflict, and thus Belgrade was saved, but, nevertheless, all Servia was lost. Then an epidemic decimated the army, and Hunyadi and Capistrano died. Despite all these horrors the Western powers were indifferent, and at length, in December, 1456, the Pope had to apply for help to the Christian King of Ethiopia and to the Christians in Syria, Georgia, and Persia. Omar Pasha had marched into Athens in June, and at the same time there was a great famine and the appearance of Halley's comet terrified the people. The great Sultan died in 1481, but the Mohammedans continued their conquests with but few checks, the Christians being too disunited to stop their advance. Belgrade finally fell into the hands of the Turks in 1521.

A.D. 1531.—At the next return, in 1531, the Turks were still advancing, but had been checked at Vienna. Germany was divided in opinion by the Protestant Reformation led by Martin Luther. In 1530 the confession of Augsburg was made, and in the following year the Protestants banded together for "the maintenance of Christian truth and peace, and for the repression of unlawful powers." Luther's idea of the Turks was that they were "ten times cleverer and more pious than our princes." He rightly attributed the Mohammedan successes to the disunion of the Christian rulers. He said: "Had Germany a master we could easily resist the Turk, . . . as the Pope has robbed us before of our money with his indulgence in the name of the Turkish war, so for our money will the Turk devour us. . . . So may Christ help us and strike both Pope and Turk to the ground." Zwingli died in 1531. In England also religious differences prevailed, and Henry VIII. claimed to be acknowledged as *supreme head of the Church and clergy of England*. Humayan was ruler of India. In Scandinavia the last rising of the Dalecarlians against Gustavus was in progress. Copernicus, the astronomer, was alive when the comet came, and may have seen it. He died in 1543. This was the first return discussed by Halley.

A.D. 1607.—James I. of England was quarrelling with his Parliament and sowing the seeds of the Revolution. The Dutch destroyed the Spanish fleet at Gibraltar and Spain sued for peace. In 1609 she recognised Holland's independence. In the New World the State of Virginia was founded by the building of Jamestown. Shakespeare and Galileo were alive; the latter died in 1642, Kepler died in 1630, and Bacon in 1626. This was the second return discussed by Halley.

A.D. 1682.—This return is noticeable for the discovery by Halley of the comet's periodic nature. Louis XIV. was King of France. Ivan and Peter the Great joint sovereigns of Russia. Outbreak of the Strelitz. Aurangzeb set out to conquer the Deccan of India. In England Monmouth raised a rebellion, but was defeated. Sir Isaac Newton assisted Halley in his researches and died in 1727.

A.D. 1759.—"Glorious fifty-nine." Our national comet was present again in 1759 to behold the world-wide triumph of the British arms. In the early part of the year the outlook for England was extremely dark and threatening. The French were known to be making efforts for the invasion of England; whilst we were at war in Germany, America, India, and on the seas. There were hostile fleets at Havre, Brest, Dunkirk, and Toulon, the first being destined as a menace to our coast, the second for the invasion of Ireland, the third of Scotland, and the fourth to give assistance to the other three. Fortunately we had men of exceptional talent at the head of affairs, such as Pitt, Admirals Boscawen, Rodney, Hawke, and Howe, and Generals Wolfe, Clive, and Coote. 1759 is described as "one of the most glorious years in the history of England, when it was necessary every morning to ask what new victory there was, for fear of missing one!" Goree was captured in January, Guadaloupe in June, Havre was bombarded by Rodney in July, the battle of Minden was won in August, Lagos and Quebec in September, and Quiberon Bay in November.

At Lagos, off the south coast of Portugal, our fleet, commanded by Admiral Boscawen, completely defeated the French, whilst at Quiberon Bay Admiral Hawke

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put an end to the naval power of France for many years, and, therefore, to all fear of invasion.

In India Clive had nearly driven the French out and made English power supreme in that country. Two years later their rule practically came to an end.

In North America the comet found the same state of affairs as far as the French and English were concerned. General Wolfe captured Quebec and Montreal and secured one of the most valuable dominions under the British flag. On the Continent of Europe the Seven Years' War raged, during which the Prussians resisted the armies of Austria, Russia, and France. Prince Ferdinand, who was in command of the allied army of English, Hanovarians, and Hessians, defeated the French at Minden—the battle which is said to have been won by a blunder! 1759 seems to have been an all-round disastrous year for France. In Portugal Charles III. was King and the Jesuits were expelled from the country. To swell the long list of British conquests Cuba was captured from Spain. In this year the comet made a fairly near approach to the earth, and the action of the latter was quite noticeable, making a difference of about 14 days in its return. It was also the first *predicted* return.

A.D. 1835.—This was the second *predicted* return of Halley's comet and also the last time, of course, that it was seen, until the present visit. In 1835 Ferdinand I. of Austria came to the throne. In Turkey Abdul-Kadir revolted. The Municipal Reform Act was passed in England. Sir Robert Peel was Prime Minister. The year before slavery was abolished throughout the British Empire; the year following, 1836, South Australia was first colonised.

The above are a few of the great events of the world when this renowned comet was present in our skies. The reader will find further study on the subject of great interest, but want of space forbids a more extended account.

Solar Disturbances During October, 1909.

By FRANK C. DENNETT.

THE increased solar energy has been maintained during October, but it has shown itself rather in the greater number of outbreaks. The longitude of the central meridian on October 1, at noon, was 204° 50′.

Nos. 102, 103, and 104.—September outbreaks remained on the disc during the earlier part of October; accordingly re-appear this month.

In a portion of the issue in our last number the numbers of 94, 97, 98, and 100 are shown, but the disturbances do not appear upon the chart, and for this reason are given again on this diagram.

No. 105.—A spotlet on 2nd, with minute pores in elliptical outline preceding. On 3rd and 5th a trail of pores 54,000 miles in length, rather less on 6th, but the eastern spot larger. Almost lost in a faculic disturbance on 7th, remaining until 9th.

No. 106.—A little group of pores on 1st, in elliptical form 2nd, a triangular group on 4th, but only one pore 5th. Revived on 6th and increased to a length of 110,000 miles on 9th, its components gradually increasing as it approached the limb until 13th.

No. 107.—First seen 5th as three small spots, a spot and pores 6th. The total area covered by this group was 110,000 miles in length and 37,000 miles in breadth, its leader growing to 21,000 miles in diameter. Behind this spot a somewhat ring-shaped compound spot was developed 11th-12th. Group last seen 17th. The whole area very active.

No. 107*a*.—A group or triangle of pores north-east of 107 seen 8th-9th and 11th-12th.

No. 108.—A pore only seen 5th and 6th.

No. 109.—A group of pores 30,000 miles long seen 9th and 10th.

No. 110.—When first seen, 8th, three small spots, the leader grew till 18,000 miles in diameter, the group reaching 74,000 miles in length. The changes among the components were rapid, only two small spots remaining 17th-18th when last observed.

No. 111.—A little pair of pores, 15,000 miles apart, seen near the central meridian on 9th only.

No. 112.—One spotlet 11th-12th, by 14th a group of pores increasing to 52,000 miles in length, and the leader to 10,000 miles in diameter. Reduced to two spots 17th-19th.

No. 113.—A little group of four pores, 30,000 miles in length, 12th to 15th.

No. 114.—A pair of pores only seen 13th-16th, immediately preceding a great faculic ridge. As they came round the limb a brilliant metallic prominence was visible, and as their place reached the central meridian there was a brilliant auroral display on 18th.

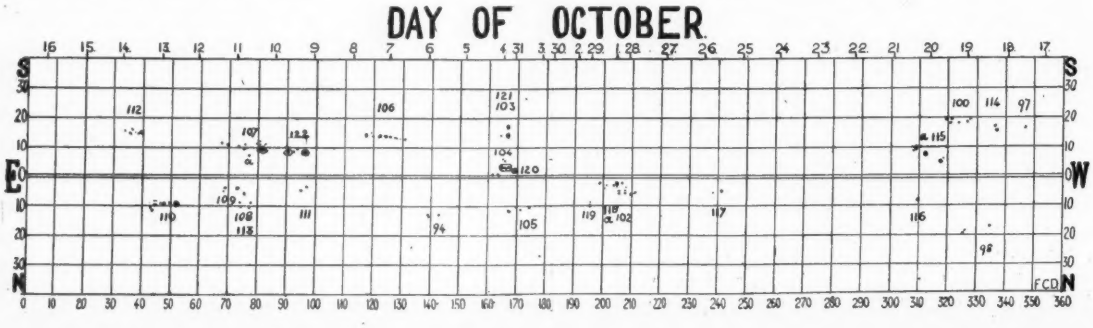
No. 115.—A small spot visible 14th-21st, solitary save for a tiny pore close west on 14th.

No. 115*a*.—A spot 14,000 miles in diameter, with a spotlet south-east, and one or two other pores when first seen on 17th. The umbra was brightly bridged 18th. After the 22nd the spot was solitary and shrinking. The group had been 52,000 miles in length. Last seen 26th.

No. 116.—A pore only seen on 20th.

No. 117.—A faculic area containing two or three pores on 21st-22nd, but only one when last seen on 25th.

No. 118.—A pore in a faculic area 23rd, next day it was like a larger spot cut in halves by a bright bridge, on 25th four pores. The greatest diameter reached 11,000 miles, and the length of the group was 60,000 miles. Seen until November 4.



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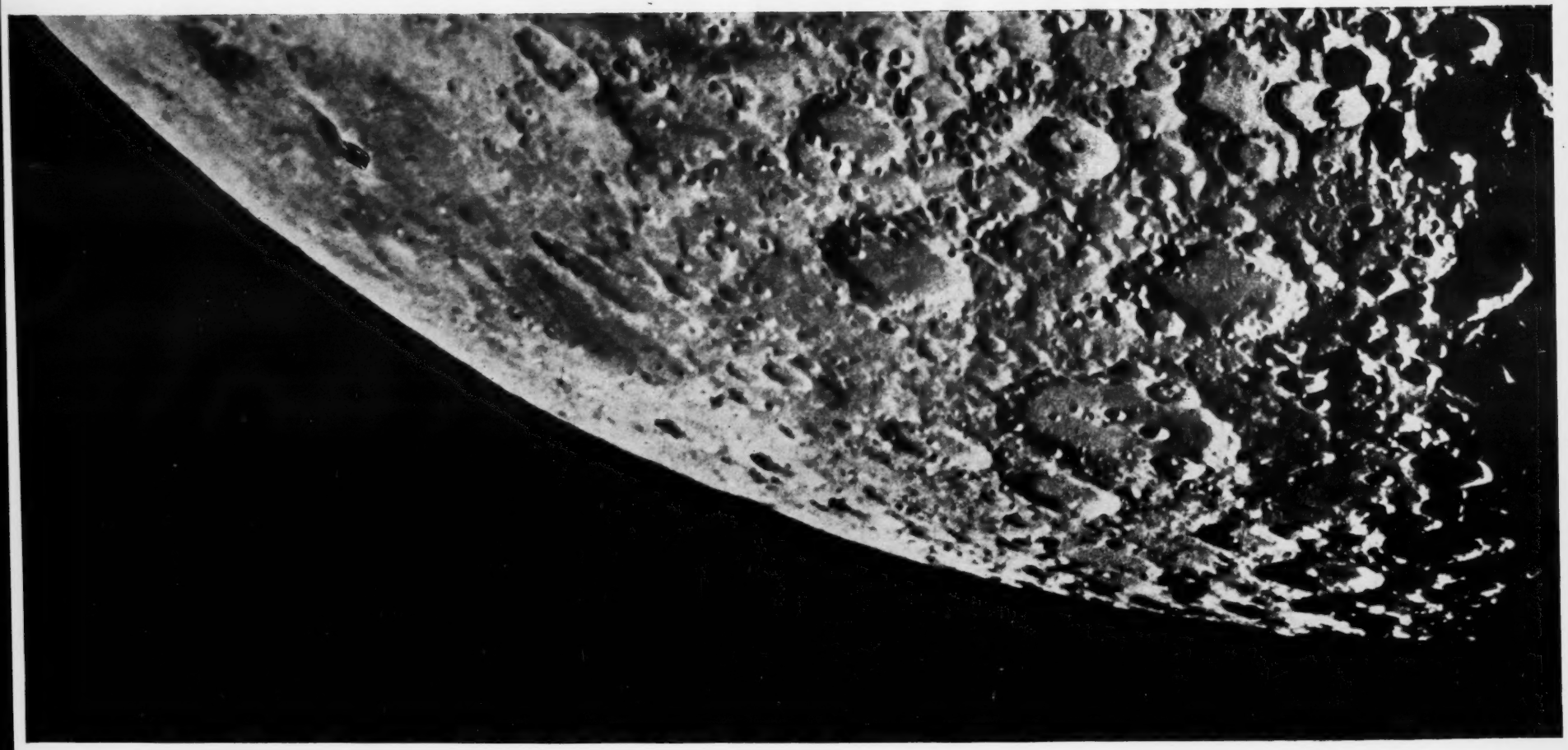

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The Moon.

No. 118*a*.—Another group of pores, one pore 31st, and a straggling line 60,000 miles in length on 1st, quite close to No. 118. Not seen after November 1.

No. 119.—A single spotlet on 23rd, on 25th a tiny companion closely south. Not seen afterwards.

No. 120.—Apparently a return of No. 104. Alone 25th to 30th. November 2 two pores appeared 67,000 miles eastward. When last seen 5th-6th it was solitary.

No. 121.—A spot some 9,000 miles in diameter October 25 to November 2. On 5th it had developed into a group of six pores, and on 6th, very near the limb, had attained a size apparently approximating to that of No. 99.

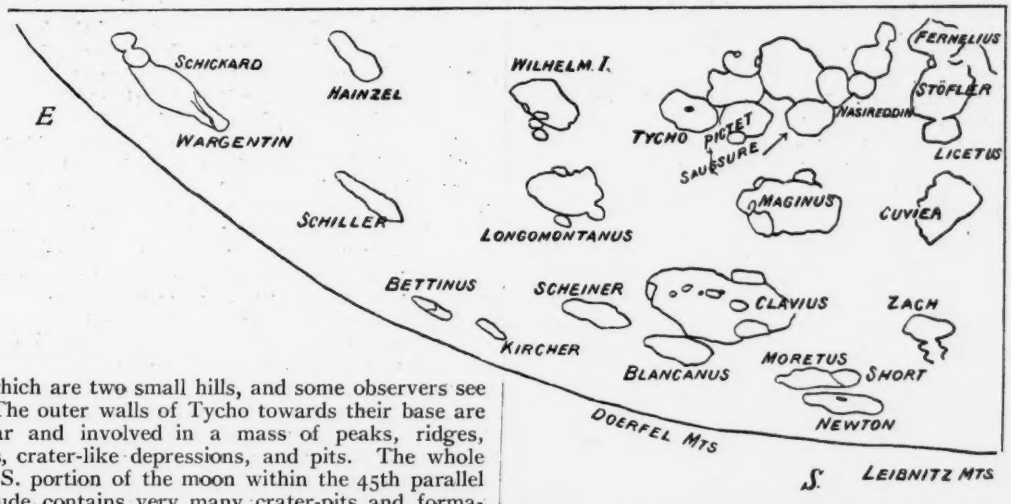
No. 122.—A group 68,000 miles in length with large spots at both extremities, first seen 31st. The western spot, 15,000 miles in diameter, but the eastern one dwindled. From November 8 until 11, when last seen, the leader was alone.

Our chart has been constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, and the writer.

Photograph of the Moon.

THE accompanying plate represents a portion of the S.E. quadrant; the following are some of the most noticeable features:—

Tycho.—A magnificent ring-plain over 54 miles in diameter. The walls contain many terraces on the interior and rise on the west to a height of about 17,113 ft. above it, and on the east 16,044 ft. There is a central mountain between 5,000 and 6,000 ft. high be-



sides which are two small hills, and some observers see five. The outer walls of Tycho towards their base are irregular and involved in a mass of peaks, ridges, mounds, crater-like depressions, and pits. The whole of this S. portion of the moon within the 45th parallel of latitude contains very many crater-pits and formations of a crater-like nature whose character it is difficult to ascertain. Tycho is remarkable as being a great centre of the streak-system best observed at full moon. These rays branch out in all directions—south they reach the limb; east as far as Hainzel; north-east beyond Bullialdus; north to Alphonsus; north-west beyond Theophilus, one even almost crossing the moon; and on the west where they are closest they almost reach the limb.

Clavius.—The next best known is this ring-plain. It is 142 miles in diameter with an area of 16,000 square miles, forming at sunrise and sunset one of the finest lunar landscapes. The walls of Clavius on the west rise to about 12,000 ft., on the east 16,837 ft., on the south-east from 10,000 to 13,000 ft., and on the north-east from 8,000 to 9,000 ft. It contains many crater-pits, long ridges, and hills. The largest of the small ring-plains near the centre of Clavius is 16 miles in diameter with terraced walls rising only 2,910 ft. above the interior, and 9,362 ft. above its floor, which must lie 23,264 ft. beneath the summit of the great peak in the centre. About five craters and over forty crater-pits occupy the interior of Clavius. From Clavius to Tycho extends a sloping decline broken by numerous depressions and crater-like formations.

Scheiner.—A large walled-plain 69½ miles in diameter surrounded by a very lofty steep wall broken by craters and terraces. On the floor are 18 crater-pits and short ridges.

Blancanus.—A ring-plain 50 miles in diameter with lofty, broad, much-terraced walls, containing fine peaks 18,008 and 13,307 ft. above the interior. The general height of the wall is over 12,000 ft. The interior is level with a few craters.

Maginus.—A much broken ring-plain with walls rising on the west 14,426 ft. above the interior, which contains comparatively few craters and mountains. The south and south-west wall consists of a mass of mountains and ridges enclosing valleys and ring-plains.

Saussure.—A ring-plain 27 miles in diameter with a wall rising 8,000 ft. high on the east. It contains a small crater and some crater-pits, four of these being in a row at the foot of the south-east wall.

Pictet.—A very irregular walled-plain surrounded by walls of unequal height and broken by small ring-plains, the average height of the border being about 3,000 ft. South of it is another small ring-plain.

Wilhelm I.—A walled-plain 46 miles in diameter with a steep, lofty wall rising on the east 11,068 ft. above the interior, but on the west only 6,682 ft. In the wall are ring-plains and craters.

Longomontanus.—A large walled-plain over 90 miles in diameter and of very considerable depth, containing several ring-plains, craters, and very small crater-pits. The highest peak on the walls is 14,542 ft.

Kircher.—A deep ring-plain with a broad, massive, and extremely lofty wall rising on the south-east to a height of 17,839 ft.

Bettinus.—A fine ring-plain containing a double-peaked central mountain, together with a lower ridge. Walls rise 13,301 ft. above interior.

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Doerfel Mountains.—A magnificent range of immense mountains rising in some places 12,000 and 26,000 ft. above the level of the limb.

Leibnitz Mountains.—A range rising in some places 26,000 and even 30,000 ft. They are probably the highest peaks of the entire visible portion of the moon. They were discovered and measured by Cassini in 1724.

Wargentin.—A very high plateau 54 miles across with a gently sloping side and scarcely any fall towards the interior. It rises 1,484 ft. on the north-east above the level plain beyond. It is quite invisible in high illuminations.

Schiller.—An elliptical ring-plain over 112 miles long and 65 miles broad with steep walls of unequal height containing many peaks.

Schickard.—A very large walled-plain about 134 miles in diameter. Its wall consists of many peaks, terraces, isolated mountains, and craters.

Hainzel.—A pear-shaped walled-plain over 55 miles in its longest diameter, with very steep, lofty walls rising in one place to a peak 11,596 ft. high. The interior is full of ridges, and two craters.

Cuvier.—A fine walled-plain with lofty walls rising at one peak 11,951 ft. high. The interior is level with a small mound in the centre.

Licetus.—Consists of a group of ring-plains united into one. The interior contains crater-pits, craters, and ridges.

Stöfler.—A large walled-plain invisible at full moon. On the interior are small hills and a steep central peak. The wall rises to a height of 11,670 ft. in one place.

Fernelius.—A walled-plain surrounded by the steep edges of broad plateaus. Interior contains minute crater-pits and low ridges.

Nasireddin.—A fine ring-plain with a lofty wall containing many peaks and rising on the east 9,600 ft. above the interior, which has a central mountain and some small crater-pits.

Moretus.—A nearly circular walled-plain 78 miles across with a wall rising in one place to a height of 15,200 ft. above the interior.

Short.—A walled-plain with a steep, lofty wall.

Newton.—Probably the deepest walled-plain upon the entire visible surface of the moon, elliptical in shape, 143 miles long, and 69 broad. Much-terraced walls rising to one peak 23,833 ft. high.

A 40-INCH MIRROR is almost completed by Clark for Prof. Percival Lowell, at Flagstaff, Arizona. The mirror is to be thicker than usual to avoid flexure, and is to have a focal length of 18 feet 4 inches. A series of zinc blocks between the iron supporting ring and the edge of the mirror avoids strains on the glass with changes of temperature. When arranged for planetary work, secondary mirrors are to be provided which will transform the instrument into a Cassegrainian reflector of either 154 feet or 75 feet focal length. For photographing nebulæ and stars a plane mirror will be used as secondary, giving the images at the principal focus.

IT appears that the Siberian railroad is beginning to show the inevitable results of the haste and cheapness with which it was constructed. The sharp curves and heavy grading have put serious limitations upon traffic, and for great distances the reconstruction will involve an entirely new location. The road is to be changed from single to double track, and the officials are greatly regretting that the large and costly bridges were built to accommodate one track only. On the level plains the double tracking will not be such a serious matter; but in the heavy cuts of the mountain division, and where the steel bridges over the wide rivers will have to be rebuilt, the cost will be very high.

Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

The Art of Focussing.

The fundamental difference between objectives for general photographic purposes and the objectives of other optical instruments is the extent of the field over which definition is required. In telescopes and microscopes the only light passed by the objective that is of use is that which enters the eyepiece, and as this is always relatively small and axially arranged, the field over which the objective has to define is also very small. But in an ordinary camera we have a plate of considerable size instead of an eyepiece, and it is necessary to get appreciably good definition over the whole of it. No lens can be made to give equally good definition over an extended field, so that the art of focussing consists in making the best of a more or less imperfect instrument. So far as the objective itself is concerned we must assume the object to be flat, or entirely at so great a distance that differences of the distances of its various parts make no appreciable difference in the result, that the sensitive plate is flat, and that the flat plate and the flat object are parallel to each other. Variations from these conditions and the way to meet them may be referred to at a subsequent time, but they affect all lenses, whatever their qualities or properties.

The photographic objectives in use before the advent of the modern anastigmat, and which are still very largely employed especially in connection with the cheaper cameras, have a field concave towards the objective and a defining power that gradually becomes less as one passes from the centre to the margins of the plate. To focus for the very centre of the image, that is, on the lens axis, would require the use of an unduly small diaphragm to avoid unsharpness at the margins, hence the custom to sacrifice a little at the centre for the sake of the margins, and the rule to focus for a part distant from the centre by about one-third of the distance of the centre from the edge. In almost all cases this will give a good average effect and enable a larger aperture to be used for the same sharpness than if the focussing were done in the very middle. But with the lenses of the modern improved types this rule fails, because in the endeavour to get a flat field and freedom from astigmatism, neither of which results is ever more than comparatively realised, the field is often not an even curve. The only way to get a rule of focussing for such instruments is to ascertain the curvature of the field or test by experiment as to the most advantageous procedure. The Goerz double anastigmat, for example, if focussed with full aperture at the very centre will be found to give a slight deterioration in sharpness as one passes from the centre, until on going further the falling off grows less and in approaching the edges of the plate it is supposed to cover with its largest aperture, the definition improves and becomes equal to that at the centre. On going further away the defining power falls off again and much more rapidly. Clearly in this case, when the lens is being used for the plate it is nominally most suitable for, the focussing may be advantageously done at the very centre, while if a larger plate is being used and the angle of view is, consequently, increased, a little allowance may be made in the central area to favour the margins, and the aperture must be reduced. Those who use lenses on other than the smallest plates or with the smallest apertures will find it advantageous to know the shape of the field of the lens and work accordingly.

The Autochrome Film. Mr. Edgar Senior, of the Battersea Polytechnic, who has been so successful in cutting and photographing transverse sections of photographic films, including the film of Lippmann interference colour photographs, has been at last successful in cutting a section of the film of an autochrome plate. The difficulties to be overcome were many. The composite character of the film led to the falling to pieces of many sections, and as the sections were floated into position in water the various layers of the film were expanded to different extents. Mr. Senior's estimate of the thickness of the original film is .1 mm., of which the varnish that holds the starch grains is .05 mm., the starch grain layer .02 mm., the varnish over the starch grains .01 mm., and the sensitive emulsion .02 mm. It seems that the attempt to get a single layer of starch granules is only approximately realised, judging from Mr. Senior's section, which shows in some parts two granules superposed. Accepting his estimate of the thickness of the starch layer as .02 mm. this tends to confirm the observation that some granules are a little distance off the plate, if not actually on the top of others, for I find the maximum diameter of the granules to be about .014 mm., and as the starch layer is rolled to flatten the granules down as much as possible the thickness of an absolutely single layer should tend to be rather less than this. Still, it is surprising that the starch layer is made as perfect as it is.

Prussian Blue. The production of prints in Prussian blue by the ordinary method is a possible process, because a ferric salt, when mixed with potassium ferricyanide in ordinary dilute solution, gives no precipitate, but only a reddish-brown colour, while if either the iron salt or the ferricyanide is reduced, as by exposure to light, a precipitate of Prussian blue is at once produced. But it was shown by Spring in 1892 that if strong solutions of ferric chloride and potassium ferricyanide are mixed, a blue precipitate is produced at once, the ferric chloride in concentrated solution and in presence of the ferricyanide decomposing apparently into ferrous chloride (which gives the dark blue precipitate) and chlorine. Yogoro Kato has recently found that ferric nitrate and ferric sulphate behave in a similar manner to ferric chloride, and that the solution of the iron salt need not be concentrated if it is added to the ferricyanide in a strong solution of some other salt, and that the blue precipitate is produced more freely in the presence of a salt of a metal of a high valency.

Radio-activity. The search for radio-activity among other substances than those well known to be active is still being carried on. When the effect sought for is small the photographic method is specially suitable, because the change produced in the plate is cumulative and may be allowed to proceed for a very long time. E. H. Buchner finds that anhydrous potassium and sodium sulphates produce no effect when allowed to remain for eighty to one hundred days or so with nothing between them and the sensitive film but 3 or 4 mm. of air. Rubidium sulphate under similar circumstances gives a clear result, and it is also effective when separated from the plate by aluminium foil .001 mm. thick. M. Levin and R. Ruer confirm previous observers that potassium salts *are* active. They have tested compounds of nearly all the elements by placing them on plates wrapped in black paper for six months. They find that potassium and rubidium compounds are active, that niobium and tantalum may be weakly active, activity in a few other cases being traced to the certain or probable presence of thorium. But the compounds of the vast majority of the elements gave no evidence of activity.

Received. From Messrs. C. P. Goerz, 1-6, Holborn Circus, a pamphlet describing their "Vest Pocket Tenax," a small camera that takes plates $1\frac{3}{4}$ by $2\frac{3}{8}$ inches ($4\frac{1}{2}$ by 6 cm.), weighs $10\frac{1}{2}$ oz., and when folded up measures $3\frac{1}{2}$ by $2\frac{3}{4}$ by 1 inches. All desirable accessories, including a special enlarger, are described.

ASTRONOMY.

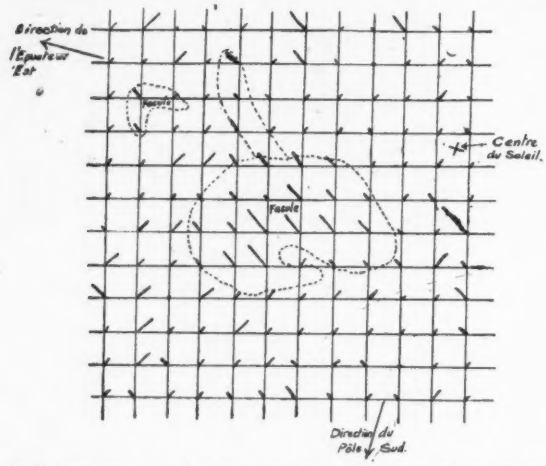
By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S., F.R.A.S.

SPECTRUM OF HALLEY'S COMET.—A recent bulletin from the Lick Observatory contains the announcement that on October 22, 1909, the spectrum of Halley's comet was photographed by Mr. W. H. Wright with a small slitless spectrograph attached to the Crossley reflector. The effective exposure was two hours, during which time the comet was followed by movable guiding wires. The plate shows a faint continuous spectrum extending from λ 3750-5000. No evidence was obtained of the existence of bright lines or bands, which usually form such characteristic features of cometary spectra. On account of the faintness of the spectrum, and being obtained without a slit, it cannot be stated with certainty whether dark lines are present.—(*Lick Observatory Bulletin*, No. 167.)

SPECTRUM OF THE ZODIACAL LIGHT.—Mr. E. A. Fath has been engaged for several years past in investigating the spectrum of the zodiacal light, employing for the purpose a specially designed spectroscope. The collimator has a triple objective 51 mm. aperture and 814 mm. focus; camera lens is a doublet, 51 mm. aperture and 154 mm. focus; the prism is of light flint of 30° refracting angle, with $\mu = 1.611$ for Hγ With this arrangement the plate had to be inclined 35° to the axis in order to get the spectrum in good focus throughout. The scale was such that from λ 3900 to λ 5900 = 2.2 mm. The first series of observations were made at Lick during August, 1907, at an altitude of 1,283 metres. Using a slit width of 0.38 mm. and a total exposure of 6h. 1m. a photograph was obtained giving indications of absorption lines near λ 4300 and λ 3950. During September of the present year a further set of observations have been made at the Solar Observatory on the summit of Mount Wilson, California. Lumière Sigma plates were employed, with a slit width of 0.41 mm. and a total exposure of 12h. 31m. The resulting spectrum very much resembles the solar spectrum photographed with the same instrument. The two absorption lines formerly suspected are confirmed to be G (Hγ) and Hε, wave-lengths 4341 and (3933-3970) respectively, the slit width being too great to resolve H and K distinctly. As there appear to be no indications of bright lines there seems no reason to doubt that the zodiacal light is mainly due to reflected sunlight.—(*Lick Observatory Bulletin*, No. 165.)

MOVEMENTS IN THE SOLAR ATMOSPHERE.—On the photographic pictures of the solar surface taken with monochromatic light by means of the spectroheliograph we have simply the forms of the various flocculous masses which happen to be radiating light of the particular colour used. To supplement the information thus obtained M. Henri Deslandres has for some years employed a second spectroheliograph for recording radial velocities, which he calls the "spectroheliograph des vitesses." This, by means of a succession of intermittent movements and intermediate exposures, permits the registration of a very small section

of the spectrum band for each of a succession of narrow bands corresponding to the primary slit. By this arrangement the displacement of the spectrum line produced by the Doppler effect of any radial movement taking place on the solar surface is photographed, and its measurement gives the desired velocity of the ascending matter. Using a powerful instrument capable of isolating the fine central core K_3 of the violet calcium line, two definite features of the solar atmosphere are shown on the photographs: (1) long, sinuous *dark* markings, called *filaments*; (2) large



Radial motions of the higher chromospheric layer radiating calcium K_3 (Deslandres). June 4, 1909. Diameter of original solar image 140 m.m.

The outline of the faculic region is indicated by a dotted line. All the radial velocities within this area are in the same direction, indicated by a small line inclined to the left. The velocities outside the area are in varied directions. Left indicates descending current; Right indicates ascending current.

flocculous areas called faculous patches, corresponding in some degree with the well-known faculæ seen in ordinary integrated light. The dark filaments are shown by their radial velocity spectra to be in ascending currents relative to the neighbouring portions of the solar surface, while the faculous patches, on the contrary, are usually descending. The accompanying figure shows exactly how these velocities are measured and plotted for the successive exposure strips, the added effect giving the general movement of the area. It will be seen at once that the velocities over the facula all agree in both direction and amount, while the velocities of the neighbouring portions are often very divergent at points near together. M. Deslandres remarks that the velocity of descent often reaches a velocity of 2 km. per second. An effort was made to compare with the above the movements of the larger radiating K_2, but it was found that the measurements were more difficult. Taking the whole structure into consideration there appears to be some similarity to the appearances shown by rotary motions in certain volatile liquids described by Benard.—(*Comptes Rendus*, No. 149, pp. 493-499, September 13, 1909.)

PHOTOGRAPHY OF THE "FLASH" SPECTRUM WITHOUT AN ECLIPSE.—The first attempts to photograph the solar atmosphere in full daylight were made by Hale in 1891 at the Kenwood Observatory, when the H and K lines of calcium, five of the ultra-violet lines of hydrogen, and the helium line at 3888.73 were recorded. Subsequent work increased the number of lines, but it was soon apparent that the chief difficulty was in consequence of the small primary solar image, so that the solar spectrum of the disc became mixed with the chromospheric spectrum, and partially obliterated it. This was improved in 1897, when the investigation was continued with the 60 ft. Yerkes' telescope. A great number of bright lines could be seen whenever the image was steady; and it was soon proved that the green fluting of carbon was present in the chromospheric spectrum. Messrs. Hale and Adams now describe the greatly improved results obtained with the Tower telescope at the solar Observatory, Mount Wilson, California, with a spectrograph of 30 ft. focal length, and give a table of 50 lines between λ4491 and λ4584, and 87 lines between λ5110 and λ5197, the visually corrected object-glass performing much better in this region. The measurements show that the chromospheric lines coincide very closely in position with the Fraunhofer lines as given by Rowland, the average systematic deviation being only + 0.002 A, which is much less than the observational error. There is thus no reason to believe that the phenomenon of anomalous dispersion has any appreciable effect on these spectra. An excellent reproduction is given, showing the chromospheric lines photographed in the green near b, including part of the green carbon fluting.—(*Astrophysical Journal*, 30, pp. 222-230, October, 1909.)

BOTANY.

By G. MASSEE.

MEXICAN RUBBER PLANTS.—Dr. H. H. Rusby has given an account in *Torreya*, of the occurrence and distribution of plants producing rubber in the Republic of Mexico. Until quite recently there was but a single known source of rubber in the country. At present two plants are contributing regular supplies, and a third is likely soon to become a very important factor in this industry, hence Mexico will become one of the most important of the world's rubber-producing countries.

The first of the rubber-producing plants is *Castilla elastica*, so abundant in one locality as to lend its provincial name, "hule," to the district and railway station known as El Hule. This tree also occurs in the West Indies. It becomes a large tree, sometimes stated to attain six feet in diameter, and lives to a great age. Owing to the destructive methods of collecting the latex there was a danger of exterminating the tree, which was only saved by the intervention of the Government. The tree is easily cultivated in suitable situations, and tapping can commence when it is from five to seven years of age. The rubber is of only medium quality.

The second plant from which rubber is obtained, *Parthenium argentatum*, a low shrub, two to three feet in height, of very slow growth, is met with on the high, dry table-land. The entire woody portions of the plant are ground to powder, and the rubber extracted by liquids from the powder. It is stated that $130,000,000 are invested in this enterprise, and that even on this great scale there is every prospect that the business will be very profitable.

The third and most recently discovered of the Mexican rubber plants is *Euphorbia elastica*, botanically related to the tree yielding Para rubber. It grows in the sub-tropical region at an altitude mostly of from 5,000 to 7,000 feet. It is a rather small tree, usually under fifty feet. The vernacular name is "palo amarillo." The great value of this tree as a rubber-producer lies in its abundance over large areas, the ease with which it can be propagated, and the rapidity of its growth. The author considers that "these considerations appear to justify the opinion that if all other sources of rubber were to fail, this one could probably supply the world's entire requirements."

ANNUAL LOSS ON FARM CROPS DUE TO FUNGI.—Professor W. A. Orton, in an article on the importance of the development of farm crops resistant to disease, justifies his statements by pointing out that the present losses from plant diseases are a heavy tax upon the farmer. He states that in the United States alone the average annual loss from oat smut is more than $6,500,000; from loose-smut of wheat, $3,000,000; and from bunt, or stinking smut of wheat, more than $11,000,000 Loose-smut annually diminishes the value of barley $2,000,000, a careful estimate of the loss in one State last year placing it as 7 per cent. The combined effect of the various diseases of fungal origin attacking the potato, diminish the yield of this crop over $36,000,000 each year. The above account shows that an annual loss amounting to over £11,000,000 is sustained, due to the injury caused by fungi to cereals and potatoes alone.

This, however, is not all; it is further stated that the

losses from the cereal rusts and from the numerous minor troubles of farm crops, concerning which accurate data are difficult to secure, amount to hundreds of millions of dollars.

Vast as is the direct loss arising from plant diseases, the indirect losses are also great, as the expense of treating plant diseases is also very considerable. Of still greater importance is the indirect loss resulting from the limitation of industries. The risk from disease frequently operates to reduce the production of otherwise profitable crops, and in many instances industries have been abandoned on this account.

The author evidently looks upon the present methods of combating fungus diseases as both costly and unsatisfactory, and indicates the need of immune varieties.

"One of the most effective methods of dealing with plant diseases is to improve our crops so that they will be less subject to injury. When we can introduce into our agriculture varieties possessing a degree of natural immunity and thereby avoid both the loss from disease and the necessity for the more or less expensive treatment by sprays and other means, a double economic gain will be secured." —("Year-Book," United States Department of Agriculture.)

LIFTING POWER OF GROWING PLANTS.—Dr. G. E. Stone gives an account in *Bull. Torrey Bot. Club*, of the force exerted by the ostrich fern (*Onoclea struthiopteris*). Young portions of this plant frequently pushed through an exceptionally hard tar-concrete pavement, 2½ to 3 inches in thickness. From experiments made it was estimated that the growing portions brought to bear a force of 190 pounds upon the concrete.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

A SUBSTITUTE FOR HYDROGEN PEROXIDE.—The ordinary commercial solutions of hydrogen peroxide in common use in laundries as bleaching reagents are prepared by suspending barium peroxide in water, treating the mixture with an acid such as hydrochloric or fluosilicic acid, and subsequently removing the barium salt. The active oxygen in the hydrogen peroxide is in a very unstable form of combination, and may be completely expelled by merely heating the solution for a few minutes. The amount of free acid left in the commercial preparations is an objection to its use for many purposes. To obviate this drawback, M. G. Jaubert recommends the use of solid salts, which when dissolved in water are decomposed with the liberation of active oxygen. Sodium perchloride, which may be taken as a typical example of these salts, is prepared by mixing sodium peroxide with about 12 times its weight of carbon tetrachloride, and passing a slow current of dry hydrochloric acid gas through the mixture, which is meanwhile chilled and kept continually stirred. The hydrochloric acid is gradually absorbed, and the resulting white precipitate of sodium perchloride is separated by filtration and dried. Until required for use it is kept in well-closed bottles to protect it from decomposition by the moisture in the atmosphere.

THE FLAVOUR OF BUTTER.—In a recent publication of the United States Department of Agriculture, experiments by Messrs. L. Rogers and Gray upon the alteration of the flavour of butter on keeping, are described in detail. It is shown that butter is very liable to develop unpleasant flavours, even when stored at so low a temperature as − 10° F., and that the amount of alteration increases with the acidity of the cream used in the preparation of the butter. This more rapid deterioration of butter from highly acid cream does not appear to be due to direct bacterial action; whilst the fact that it still occurs in cream that has been sterilised by heat shows that it is not caused by enzymes. The main cause appears to be decomposition of certain unstable compounds in the butter by lactic acid, and the same result may be produced by the acid normally formed by the lactic acid bacteria in the cream, or by lactic acid artificially added to sterilised cream.

It is quite possible to make butter from sweet sterilised cream, provided the temperature and speed of churning are suitably regulated, and fresh butter thus prepared shows much less change when stored than ordinary butter from sour cream. The chief objection to sweet-cream butter is that its flavour is too mild for the average taste, and that woody or other extraneous flavours are more noticeable than in the case of butters of more pronounced flavour.

"CORK METAL."—A material recently exhibited at an aeronautical exhibition under the name of "cork metal," was claimed to excel aluminium in many respects, and in particular to be about 40 per cent. lighter than that metal. The exact nature of this substance was kept secret, but a sample of it has been analysed by Mr. F. J. Willott, and found to have the following composition: Aluminium, 0.04; iron, 0.017; zinc, 0.48; sodium, 0.21; and magnesium, 99.30 per cent. It was of a greyish-white colour, and in appearance it resembled the alloys termed *magnalium*. When immersed in water it emitted hydrogen, and is was therefore necessary to determine its specific gravity in alcohol. The value obtained (1.762) confirmed the conclusion drawn from the chemical analysis, that "cork metal" is nothing more than impure magnesium. The small proportion of zinc present was probably an impurity of the manufacture.

UTILISATION OF SPENT HOPS.—All attempts to utilise in a profitable manner the spent hops from breweries have hitherto proved only partially successful. The fibre is practically valueless for the manufacture of paper, and at best could only be used for the very coarsest kinds. At present the waste material is usually incorporated with farmyard manure and, employed as a fertiliser. Although fairly rich in nutrient constituents it cannot in its ordinary state be used as a feeding-stuff owing to the large proportion of indigestible woody fibre that it contains. Recent experiments made by Messrs. Beadle and Stevens, however, have shown, that by suitable treatment with a dilute acid, the cellulose of the fibre may be hydrolysed and converted into soluble substances, so as to yield a product which can be given to cattle in admixture with other foodstuffs. The spent hops, which contain about 70 per cent. of water, are first pressed to remove this excess of moisture, and are then subjected under pressure at a temperature above 100° C., to the action of hydrochloric acid gas. At a certain critical temperature (slightly above 100° C.), the cellulose is hydrolysed. The process is then stopped and the material piled into heaps and left for further spontaneous changes to occur. Finally it is ground to a meal and dried. Specimens of the product thus obtained contained about 10 per cent of moisture, 6 to 7 per cent. of mineral matter (ash), 6 to 10 per cent. of fat, 19 to 21 per cent. of proteins, and 26 to 33 per cent. of hydrocellulose. The astringent principle in the hops should be counter-balanced by blending the meal with food stuffs containing oil. Practical feeding experiments have shown that the hydrolysed hop meal produces no ill effects in the cattle, and that its value as a food stuff is about £5 per ton.

GEOLOGY.

By EDWARD A. MARTIN, F.G.S.

NORTHUMBRIAN DYKES.—At the meeting of the Geological Society on November 13 a paper on the "Dyke at Crookdene (Northumberland), and its relations to the Collywell, Morpeth, and Tynemouth Dykes" was read by Miss M. K. Heslop, M.Sc., and Dr. J. A. Smythe. The dyke at Crookdene is exposed in the bed and banks of the Wansbeck about 15 miles above Morpeth. It is intruded along a fault-fissure in beds of Bernician age, and apparently comes to a natural head. The basalt is characterised, microscopically, by narrow lath-shaped felspars and curved augites. Macroscopically, its most interesting feature is the occurrence of large inclusions of a felspar, which is shown by chemical analysis to be closely allied to anorthite. The exterior of the inclusions in contact with the groundmass is strongly zoned, the later showing a slightly chilled edge; the individual crystals are intergrown and are cracked, faulted, and in places completely shattered. In no case is the dislocation great, and, in fact, the crystals seem to have burst *in situ*. These phenomena point to a plutonic origin of the felspathic inclusions and connect them with the porphyritic felspars of the Tynemouth dyke, for which a similar origin has already been suggested by Teall. The dyke which

comes to a head in the coast-section at Collywell, about 24 miles distant, shows almost precisely the same peculiarities. Chemical and microscopical examination of the two basalts and their felspathic inclusions show them to be practically identical. Considering these facts and the general field-relationships of the dykes, it appears probable that they belong to the same instrusion. The resemblances among the four dykes are so strong as to render it probable that they are derived from a common source. The observed differences are such as could be readily accounted for by differences of physical condition operating during the period of consolidation of the dykes.

GEOLOGY OF NYASSALAND.—The Geology of Nyassaland was the subject of a paper by A. R. Andrew and T. E. G. Bailey, read before the Geological Society. The greater part of Nyassaland consists of crystalline rocks, which comprise, according to the authors of the paper (*a*) highly metamorphosed sedimentary beds, including graphitic gneisses with limestones, and muscovite schists; (*b*) foliated igneous rocks, especially augen-gneiss, derived from granite or syenite; (*c*) plutonic intrusions, usually granite or syenite, more rarely gabbro. In two localities nepheline and sodalite syenites are found; these are, perhaps, of the same age as the similar post-Waterberg and pre-Karoo syenites of the Transvaal. In the north-west corner of Nyassaland is a somewhat altered sedimentary series, which forms the Mafingi Hills. It consists of a thick accumulation of quartzites, grits, and sandstones of pre-Karoo age. The Karoo system is represented both in the north and south of Nyassaland; in the north it occurs in patches, which owe their preservation to faulting. It has afforded remains of fresh-water lamellibranchs (*Palæomutela*), fish-scales (*Acrolepis*), and species of *Glossopteris*. Recent lacustrine marls and sands are found at great heights above the present level of the lake, and as much as 15 miles away from its margin. Pumiceous tuffs, associated with recent gravels containing pebbles of Tertiary lava, are found in the extreme north of the country; across the border, in German East Africa, Tertiary and recent lavas and tuffs are widely distributed. Nyassaland consists of high plateaux rising irregularly one above the other. The Nyika and Vipya plateaux were no doubt at one time continuous as "a platform of erosion" which originated after the main faulting of the Karoo in Northern Nyassaland, and before the formation of the great Nyassa fault-trough.

THE GRANITE RIDGES OF KHARGA OASIS.—At the Geological Society meeting on November 4 Dr. W. F. Hume read a paper on "The Granite Ridges of Kharga Oasis: Intrusive or Tectonic?" Whereas Mr. Beadnell regarded the granite as intrusive, on account of the high dip of the sedimentaries, and the charges they exhibit as regards colour and hardness, near the granite, as described in a paper read during last session, Dr. Hume considers that the dips are due to fold movements almost at right angles to one another, since they lie on the same line as the crater-like basins, whose rims are formed of the compact and steep-dipping limestones of the Lower Eocene, and he adduces as further evidence the fact that dykes and quartz-veins penetrating the crystalline rocks cease abruptly at the edge of the sandstone. He attributes the bright hues and silicification found near the contact to gases and heated waters acting along the boundary between the dissimilar rock-masses.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

PHENOLOGICAL OBSERVATIONS AT NORWICH.—Mr. A. W. Preston, in his meteorological report to the Norfolk and Norwich Naturalists' Society for last year, gave a summary of the results obtained from his meteorological and phenological observations at Norwich during the 10 years, 1898-1907, and also the averages for the 20 years, 1888-1907.

The following are the 20 years' averages of some of the phenological results:

FIRST LEAFING OF TREES.

Hawthorn	March 18	Beech	April 26
Sycamore	April 6	Elm	,, 30
Horse Chestnut ..	,, 6	Maple	,, 30
Lime	,, 17	Oak	May 5
Birch	,, 22	Ash	,, 14

FIRST FLOWERING OF PLANTS.

Winter Aconite ..	Jan. 4	Blackthorn	April 14
Snowdrop	,, 17	Bluebell	May 1
Crocus	Feb. 5	Lilac	,, 12
Daffodil	March 20	Laburnum	,, 15
Wood Anemone ..	,, 31	Dog Rose	June 13

HARVEST OPERATIONS.

Hay cut	June 14	Wheat cut	Aug. 7
Wheat ear .. .	,, 17	Harvest finished ..	Sept. 8

BIRDS.

Cuckoo heard ..	April 22	Nightingale heard ..	April 24

ROYAL METEOROLOGICAL SOCIETY.—The first meeting of this Society for the present session was held on November 17, at the Institution of Civil Engineers, when Mr. C. J. P. Cave gave an account of the methods which he employed for observing pilot balloons, which are used for investigating the currents of the upper atmosphere. Two theodolites are used, one at each end of a measured base-line, and observations of the balloon are taken each minute from its start. The readings are subsequently worked out and plotted graphically, when the height, direction, and rate of travel of the balloon during its course are determined. The best time for observing balloons is shortly before sunset, as the sky will be becoming dark when the balloon reaches its greatest height, and being illuminated by direct sunlight will shine like a star. Mr. Cave has seen a balloon burst at a distance of 40 miles under these conditions. The rate of ascent of balloons is found to vary considerably near the ground, and in cloudy weather particularly when there is cumulus cloud, but higher up the rate of ascent remains fairly uniform up to great heights.

Mr. W. Marriott read a paper on the "Registering Balloon Ascents at Gloucester, June 23 and 24, 1909." During the Royal Agricultural Society's recent Show the author sent up ballon-sondes with recording instruments on three consecutive days. Two of the meteorographs were found and returned. The balloon on the 23rd fell 37 miles south-east, and that on the 24th fell 43 miles north of Gloucester. The records showed that the temperature decreased pretty uniformly up to between 5 and 6 miles; above that height the temperature increased somewhat and then kept nearly stationary up to the highest point reached by the balloons, about 12 miles. The temperature recorded on the 23rd was higher than that recorded on the 24th, and the point of change, or the beginning of the so-called "isothermal layer," was about half-a-mile lower in altitude. This was probably due to the balloon on the 23rd having ascended on the eastern side of the centre of a cyclone, while that on the 24th ascended on the western side of the centre.

A paper on "Winter Temperatures on Mountain Heights," by Mr. W. Pifle Brown, was read by the Secretary. In 1867 the author placed a minimum thermometer on the summit of Y Glyder-fach, a mountain near Snowdon, and 3,262 feet above sea-level, and this has been regularly observed and the lowest winter readings recorded each year. The author gave the readings in full.

Mr. E. Gold also read a paper on "The Semi-Diurnal Variation of Rainfall." The results of his investigations seem to indicate that the upward motion associated with the semi-diurnal variation of pressure is the probable cause of the semi-diurnal variation of rainfall.

HEAVY RAINFALL IN THE SOUTH OF ENGLAND.—Very heavy and persistent rains fell over the south and south-east of England during the last week in October. These were associated with a barometrical depression which appeared over the south-west of Ireland on the 25th and subsequently moved in a slow and somewhat erratic manner along the English Channel. At most of the stations in the southern counties rain commenced early on the 26th and continued with scarcely any intermission until the 29th. As much as 3.60 ins. fell at Brighton on the 26th, and 3.14 ins. at

Broadstairs, and 3.00 ins. at Folkestone on the 28th. Very extensive flooding resulted from these heavy rains, and many thousand sheep were said to have been lost from Kentish pastures.

SYMONS' GOLD MEDAL.—The Council of the Royal Meteorological Society have awarded the Symons' Gold Medal to Dr. William Napier Shaw, F.R.S., the Director of the Meteorological Office, "in recognition of the valuable work which he has done in connection with meteorological science." The Medal will be presented at the Annual Meeting of the Society on January 20, 1910.

ORNITHOLOGY.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

THE HOME-LIFE OF A GOLDEN EAGLE.—Mr. H. B. Macpherson has just achieved a triumph in the art of bird watching; and in placing the details of his feat on record he has done ornithologists a service for which they should be truly grateful.

He conceived the idea of studying, at close quarters, the domestic economy of the Golden Eagle, one of the finest of the birds of prey which the "sportsman" has left to us, but in carrying his design into effect he found himself confronted with more than ordinary difficulties, and on more than one occasion was in danger of his life, for eagles, happily, have a habit of choosing inaccessible places wherein to nest. Nevertheless, in spite of difficulties which would have deterred most men, privations, and exposure to intense cold, he succeeded in carrying his design into effect, and in securing a perfectly wonderful series of photographs.

Of the loving care bestowed by the parents on their young, their methods of brooding, feeding, and education, Mr. Macpherson gives a perfectly delightful account, but of these matters, and much else, space forbids us to say anything here. We, however, most earnestly commend Mr. Macpherson's book to the attention of our readers, who may be glad to know that it may be obtained of Messrs. Witherby and Co. for the small sum of 5s. Of its kind this book ranks among the very first that have ever been written.

THE PLUMAGE OF THE CORMORANT.—It is commonly supposed that little that is new is now to be said about our British birds, an impression which has gained currency very largely from the fact that most of the modern books on our native avifauna are mere compilations. As a matter of fact we have but touched the fringe of the subject.

To the *Field* (November 13), Mr. F. W. Frohawk contributes a long and most interesting article on the immature plumage of the Cormorant, in which he sums up the statement of earlier writers on this theme, and adds a number of new facts based on his own obsevations, illustrating these notes by a most excellent picture. From Mr. Frohawk's observations it seems clear that the fully adult plumage takes longer to acquire than has generally been supposed.

ORTOLAN BUNTINGS IN NORFOLK.—Mr. F. J. Richards, in *British Birds* for November, reports the occurrence of an unusual number of Ortolans (*Emleriza hortulana*) in Norfolk during the past autumn. Five were killed at Cley during September, while others were seen.

GLOSSY IBIS IN YORKSHIRE, NOTTS., AND DEVON.—To the *Field* (November 6), Mr. Edward Mitford sends a photograph of a Glossy Ibis shot near Hunmanby on October 15; two others were seen. The bird secured was immature. This apparently is the sixth recorded occurrence of this species in Yorkshire. The specimen obtained in Devon was killed during the last week in October, after an easterly gale, near the estuary of the rivers Taw and Torridge. The specimen recorded from Notts. was killed about the middle of October at Misson, and was sold to a game dealer for a shilling! Happily, it was seen by Dr. Corbett, who purchased it for the Doncaster Museum.

BLACK-WINGED PRATINCOLE IN YORKSHIRE.—Mr. T. H. Nelson, in the *Field* (November 13), reports the fact that a Black-Winged Pratincole (*Glareola melanoptera*) was shot by Mr. W. Charlton at Danby Wiske, near Northallerton, on August 17 last.

SPOONBILL IN DEVON.—It would seem that within two days of the capture of the Glossy Ibis near the estuary of the Taw and Torridge, another gunner obtained a Spoonbill; but details as to the sex and condition of the bird are not given.

PHYSICS.

By PROFESSOR A. W. PORTER, B.Sc.

THE PROPERTIES OF GOLD LEAF AT HIGH TEMPERATURES.—Last year Professor Turner showed that gold leaf becomes transparent when heated in contact with glass. Messrs. J. C. Chapman and H. L. Porter have now carried out experiments to see whether the same thing happens when the gold leaf is heated by itself. The gold leaf was stuck all round its edges to a platinum loop and heated in a double-walled quartz crucible. No increase in transparency took place, but as heating continued it was noticed that the gold leaf was becoming more taut, and eventually the tension became so great that the leaf tore in places. The above shows that at a sufficiently high temperature gold leaf contracts. On examining it microscopically after removal its structure appeared to be decidedly more granular. Subsequent experiments with the leaf hanging like a blind with a weight at the bottom to put it under definite tension showed that as the temperature rose the contraction when it began took place at a great rate with increase in temperature. When different tensions were employed the contraction temperature was nearly the same in all, and was about 340° C. With gold wire instead of leaf no contraction took place. The extra transparency when the leaf is heated in contact with glass is attributed to this contraction, it being shown that the leaf tears on contraction at numerous places, leaving clear intervals between.—(*Roy. Soc. Proc.*, No. A 559.)

MINUTE INTERFEROMETERS.—The question of how small a volume of gas it is sufficient to use in determining its refractivity is an important one at the present day when several rare gases are known. The rarest of all these that have been obtained in visible quantity is the emanation from radium. Since the amount possessed by any individual at any one time does not amount to more than a fraction of a cubic millimetre, it is clear that any refractometer must have minute dimensions if intended for this gas.

Lord Rayleigh has recently investigated the greatest reduction in size which permits satisfactory measurements to be made with the kind of interferometer which he employed to measure the refractivity of argon. He found that it was quite practicable to use the apparatus when the tube containing the gas was only two centimetres long and had a volume of about four cubic millimetres; and he did not doubt that further reduction was possible.

Mr. Clive Cuthbertson and the present writer have also been working towards the same end at intervals during the last two years. We succeeded last year in using a small vessel only about 2 *millimetres* long, and though the volume of the particular vessel was about 2 cubic millimetres, we demonstrated by the use of diaphragms that a considerable reduction in the cross-section could be effected without detriment to the efficiency of the apparatus. The vessel was made by sealing a capillary tube at one end, drilling a transverse hole at the end of the cavity (like the eye of a needle), grinding two opposite faces flat in the neighbourhood of the hole, so that small parallel faced plates could be cemented in position with their surfaces at right angles to the hole. The slabs so cemented on were previously silvered (or platinised) on the surfaces placed on the inside. A small chamber was thus formed through the silvered surfaces of which a beam of monochromatic light (mercury green) could be passed. The arrangement constitutes a Fabry and Perot interferometer; interference bands are visible when the transmitted light is examined by a telescope focussed approximately for infinity. If a gas is now compressed into the small chamber the interference bands move across the cross-wire; and the passage of a complete band implies that extra time equal to one

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complete period of the light employed has been taken for it to go once backwards and forwards between the silvered surfaces. Since the refractive index of a substance is proportional to the *slowness* with which the light travels, the change in the index can be calculated from a knowledge of the number of bands which pass over the wire for a known difference of pressure, together with the distance between the silvered surfaces. The interference bands were very fine, and it was easy to read to a hundredth part of a band. In spite of the smallness of the apparatus the value obtained for air (used as a test gas) was correct to within about 2 per cent. We have not succeeded so far in obtaining the emanation pure enough to rely upon the index obtained for it. Impure emanations would suffice if the impurities were definitely known, but that is not the case. Preparations are being made for a fresh attempt with still smaller apparatus and we hope ultimately to succeed. Some further details are given in a letter to *Nature*, November 4, and the account of Lord Rayleigh's experiments is in the previous number of the same journal.

ZOOLOGY.

By R. LYDEKKER.

THE COLOURING OF HORSES.—Great interest attaches to a paper by Mr. R. I. Pocock on the colouring of horses, zebras, and tapirs, published in the November number of the Annals and Magazine of Natural History. As regards domesticated horses, the author is of opinion that their colour-types may be arranged in three groups: the first comprising bays, blacks, chestnuts, roans, and piebalds, the second duns, and the third greys and the majority of whites. Bay appears to be the primitive phase of the first type, blacks and browns being melanisms; and chestnuts, "erythrisms," or red sports, the latter conclusion being based on the fact that in all wild members of the horse-family the mane and tail are darker than the body-colour. A white star on the forehead and white fetlocks are signs of incipient albinism, and not, as has been suggested, original features of the ancestor of the Arab and thoroughbred type. Since dappling may appear in horses of all colours, although rare in duns, it is evidently a very ancient feature; and leads to the conclusion that it is older than stripes. Moreover, it seems probable that the ancestors of the horse-family were originally dark-coloured animals with white markings, comparable to a great extent in this respect with young tapirs. The white markings were originally in the form of spots, which tended at first to run into longitudinal lines, but subsequently arranged themselves in transverse bars on most of the head and body. If this view be correct, zebras are really black or brown animals with white or buff stripes, and not white or buff ones with black or brown stripes; just as giraffes were originally brown or red animals with white markings of the type of those of bushbucks. We shall all look at zebras and dappled horses in quite a new light, and with much greater interest than ever before.

THE AFFINITIES OF CŒNOLESTES.—The curious South American marsupials described as *Cœnolestes* have been generally classed with the diprotodont section of the order, which includes the Australian kangaroos, phalangers, and wombats; the main ground for the reference to that group being the fact that the lower jaw is armed with a single pair of large, forwardly projecting, chisel-like teeth. It has, however, been pointed out in the October number of the American *Naturalist* that the dental formula of *Cœnolestes* is identical with that of the Tasmanian wolf and the pouched mice, belonging to the polyprotodont section of the group; there being two pairs of small functionless lower incisors behind the large chisel-like pair. Further, there is a close general resemblance in bodily form between these animals and the Australian pouched mice (*Phascologale*) on the one hand, and the American opossums (*Didelphys*) on the other. The skull likewise presents a marked similarity to that of the smaller Australasian polyprotodonts; while the rudimentary pouch is paralleled among the pouched mice and the smaller American opossums. Then, again, the fore and hind limbs are approximately equal in length, the two outer toes are fully developed and distinct, as in polyprotodonts, and the plantigrade feet in the number and position of their pads and the short and clawless condition of the first hind-toe are exactly comparable with those of the pouched mice. These facts suggest that the resemblances in the dentition of *Cœnolestes* to that of the Australian opossums, or phalangers, as they are called by naturalists, is due to convergence and not to genetic affinity; for excepting tooth-structure there appears to be no important character linking *Cœnolestes* with the diprotodonts, while there are several which connect it with the polyprotodonts. The point is of more importance than might appear at first sight to be the case, since *Cœnolestes* is only the last survivor of a host of extinct South American marsupials.

TEMPERATURE OF CAMELS.—I have been much interested in certain observations recently made in Australia to the effect that camels display considerable diurnal variation in the temperature of their blood; this falling during cold nights, and rising gradually during the day. In this oscillation of temperature camels display a reptilian feature; and it is not a little remarkable that (together with llamas) they likewise approximate to reptiles in having oval blood-corpuscles. The question arises as to whether there is any connection between these two phenomena; but the answer is probably in the negative.

REVIEWS OF BOOKS.

BOTANY.

Botany of To-day, by G. F. Scott Elliot, M.A., etc. (Seeley and Co., Ltd.; 5s. net).—From past experience we are led to expect something far removed from the orthodox style of dealing with botany, from Mr. Scott Elliot's pen, and in the present instance we are not disappointed, in fact, as expressed by the title, the book under consideration deals with the subject in a truly scientific manner, but the science is so expressed that it becomes not only intelligible, but at the same time highly interesting to the layman. The reader is first introduced to protoplasm, or the seat of life, and by degrees to the various forms of plant life resulting from the very varied activity of protoplasm, favoured or hindered, as the case may be, by external conflicting forces. Next follows a lucid description of the ways and means adopted by plants for holding their own ground in the universal struggle for existence, and also the contrivances for extending their geographical range. The chapters on "The Origin of our British Flora" and "The Practice and Theory of Plant Breeding" are excellent illustrations of dealing with knotty points in a manner that can be grasped by all. A valuable feature of the book is the very considerable number of references given, thus affording the reader an opportunity of consulting the original source of information when desirable. The numerous whole-page illustrations add much to the value of the book.

CHEMISTRY.

Outlines of Chemistry, Part I., by H. J. H. Fenton, M.A., Sc.D., F.R.S. (Cambridge University Press; pp. xvi. and 367; 9s. net).—This book is the outcome of the author's solution of the difficult problem of covering a wide field in a short time without encouraging superficiality. It is primarily intended for those students working for the Natural Sciences Tripos for whom the time allotted to chemistry is compressed into a very limited compass. The method of teaching here advocated is to regard each section (for example, atomic weights) as an independent subject, and after the lecture to make each student do practical work bearing upon the theoretical principles. Informal discussions are also held to clear the ground of difficulties, and to suggest additional sources for reference, and prior to the next lecture the student is directed to "look up" what has been written upon the subject. It will thus be seen that this book, which embodies this method of teaching, is not intended to take the place of the well-known larger works on chemistry, but rather to serve as a connecting link between them all. Through it all runs the idea of the necessity of inculcating reliance upon self in the scientific

worker. Even the directions for the experiments are made very brief, with the object of drawing out the practical resource of the student; and in disputed questions of theory there is no dogmatism, but the evidence on each side is brought forward, and the student is left to draw his own conclusions. The book may be warmly recommended not only to those who are studying for any particular examination, but to all who are anxious to obtain a thorough grasp of the principles of chemistry. Like all works issuing from the Cambridge Press, it is clearly arranged and printed, and, it may be added, gains much from the excellent diagrams of apparatus specially drawn for it by Mr. Shillington Scales, M.A.

The Vegetable Proteins, by T. B. Osborne, Ph.D. (Longnans; pp. xiii. and 125; 3s. 6d. net).—In the past there has been considerable confusion with regard to the nomenclature of the class of substances dealt with in this monograph. They were sometimes termed albuminoids and sometimes proteids, while in some classifications these terms were applied only to sub-divisions of the class. The term "protein," however, is now adopted in this country and America as the generic term for the whole class of complex nitrogenous substances occurring in animal and vegetable structures and typified by albumin and gelatin. The present work is confined to the proteins of the vegetable kingdom, and, as in other monographs, in this series the aim has been to give a general survey of the physical and chemical properties of the class rather than to deal minutely with those of individual compounds. The methods of isolation and preparation, the composition and properties, and the classification of vegetable proteins are described in the first ten chapters, and these are followed by an interesting chapter on the physiological relationships of these substances towards the animal organism. There is also an excellent bibliography of the scientific literature of the subject. Both as a practical handbook and as a reference index, the monograph will be of the greatest use to the worker in biochemistry.

NATURAL HISTORY.

Nature, by J. H. Crawford (Swan Sonnenschein and Co., Ltd.; 242 pp., illustrated; 5s.).—The title of this work is certainly a comprehensive one, and with such a title an author might write about practically anything. However, he deals with the "authorised" book of Nature, of spring, contrasts between town and country, life on the moorland, along the shores, and on the wind. The material is good, but long drawn-out. The style is stilted, as though he were emulating Carlyle. Many a sentence is superfluous, and it is not exactly a pleasure to work through the book. "Humanity will be ever so much more attractive when peeps of sky and green fields appear between the men and women." So says the author, and we agree. There are moments, indeed, when the less of humanity and the more of the lower ranks of Nature the better.

PHILOSOPHY.

Progressive Creation; A Reconciliation of Religion with Science, by the Rev. Holden L. Sampson. In two vols. (Rebman, Ltd.; 21s. net).—If we class the Rev. Holden Sampson's monumental work as philosophy, it is with the reservation that the philosophy is extremely speculative, even though the intention be irreproachable. It is intended by the earnest writer who compiles it to reconcile the conflicting beliefs of science and religion; but before we can admit the reconciliation we require to be convinced that the grounds of conflict are correctly stated on either side. Is it true, for example, that any creed or religion definitely asserts a belief in the progressive evolution of gods? In many it has been believed that man steps by successive stages to something higher than himself; in some he returns, as the poet Gray reverently said, to "the bosom of his Father and his God"; but in the vast majority of religions the ultimate gods stand high above men. Nor are we in any way disposed to accept Mr. Sampson's statements of the scientific theories of geological evolution; and, as a matter of fact, thus stated they are scarcely more fanciful than his own hypothesis that "the earth was once a perfect planet, generating its own heat and producing flora and fauna of perfect types; and that the sun at that time exercised nothing of the fiery influence it does." But if we are disposed on the whole not to agree with the author's statements or his deductions, we are prepared to admit a vast and industrious attempt on his part to work out logical deductions from his premises. He has brought much research and curious learning to his task and in one particular we are in entire agreement with him: and it is in his warning to both men and women to avoid indiscriminate, incautious, and promiscuous dealing with spiritualism.

PHYSICS.

Harmonic Vibrations and Vibration Figures, by Joseph Gould, C. E. Benham, R. Kerr, and Professor L. R. Wilberforce. Edited by H. C. Newton (London: Newton and Co.; 6s. net).—This volume describes the many beautiful effects that can be obtained with harmonographs, vortex plates, etc.; and the interesting phenomena of mutual interchange of energy displayed by Professor Wilberforce's synchronous springs. The book is throughout illustrated with exceedingly interesting reproductions of the figures obtained. It is true, perhaps, that emphasis seems to be laid rather on the æsthetic effects produced than on their scientific importance; though exception must be made in the case of Professor Wilberforce's experiments. It may be mentioned that an interesting variant of the latter is obtainable by suspending two bar magnets, so as to lie in the same horizontal line, by means of strings. If one of them is displaced along this line a similar interchange of energy between the two magnets takes place as in Wilberforce's experiment. The book will prove of very great interest to our readers.

The Ether of Space, by Sir O. Lodge (Harper and Brothers; 2s. 6s. net cloth; 3s. 6d. net leather).—A volume by Sir Oliver Lodge is certain to possess distinction, and when the subject matter is the investigation of the nature and properties of the ether of space which has long been to him the most fascinating branch of physics great expectations are certain to be rewarded. The subject is not altogether an easy one to deal with, but the vivid illustrations employed will tend to remove much of the difficulty for those who have not received a special training in the higher branches of physics. Reasons are given for supposing that the density of the ether is 10^{12} grams. per cubic centimetre, that is, one million million times the density of water! Sir Oliver seems to be in doubt how to spell ethereal when it is not intended to convey the idea of something unsubstantial. Is not the best way to spell it with an initial diphthong, æ? May we point out one small inaccuracy? The path of a ray of light is sometimes the longest-time path, not the shortest. Is it not time that text-books began generally to recognise that the criterion of a ray is that it shall occupy neither greater nor less time than the immediately adjacent paths?

MISCELLANEOUS.

The Survival of Man, by Sir Oliver Lodge (Methuen and Co.; 7s. 6d. net).—A short statement of the purpose of this book would be that in it the author endeavours to show that the spirit of man survives his bodily death because in life his spirit displays possibilities of making itself felt in other than material ways. In other words, Sir Oliver Lodge's chain is as follows: Thought-reading, thought-transference, unconscious thought-transference, unconscious thought-transference from the dying to the living, conscious thought-transference from the dead to the living, and, therefore, survival of some essence of life in those whom we call dead. We can only profess ourselves unconvinced by the chain of proof; and we are unconvinced, not so much because we dispute the validity of the links in the chain, or Sir Oliver Lodge's ability to test these links; but because the very strength of the earlier links creates an interrogation as to the strength of the later ones. If thought-transference is an indisputable fact, then when a "medium" tells us that he or she is repeating expressions conveyed to him or her by the dead, we are justified in believing that the medium is mistaken, and that what he or she is translating is the unconsciously transferred thought waves of those who are credulous listeners of the "medium's" outpourings.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, M.A., F.R.M.S.

Ultra-microscopic Particles.

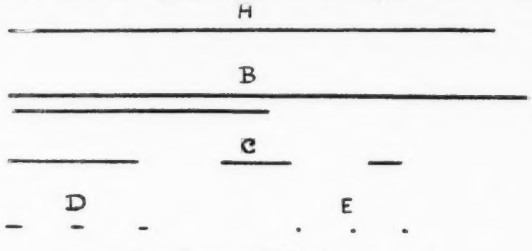
A good deal of misunderstanding exists as to the meaning of the expression "ultra-microscopic particle," and as to what is meant by the term "beyond the limits of microscopic resolution." The fact is that a sharp distinction must be made between the mere making visible of an object so that we can be made aware that such an object exists, and the seeing of it so clearly and so well resolved that we know what its actual appearance is like. One may draw a parallel between the appearance presented by a star in the heavens which appears merely as a point of light, and which our most powerful telescopes have never succeeded in making anything but such a point of light, and a planet, which to the naked eye looks like a somewhat similar point of light, but which a good telescope shows to be a circular disc with markings upon it. It is not really a question of magnification, it is rather a question of "resolution," the power of an objective to show structure. In the case of a telescopic object-glass increased magnification and increased power of showing detail go together, but in the microscope objective the "aperture" of the objective alone decides the amount of detail that it can show, and as we cannot at present increase the aperture of our objectives beyond a certain point, and yet can make objectives of $\frac{1}{8}$ or $\frac{1}{12}$ of an inch, or even less, with this maximum aperture, we gain no advantage by increasing our magnification beyond this point, whilst we do get many distinct disadvantages. It is for this reason that high-power objectives like $\frac{1}{25}$ and $\frac{1}{50}$ of an inch are now so seldom met with.

Now, it has been found that with our microscope objectives of highest aperture we are able to resolve a couple of lines about a quarter of a micron apart, the micron being the one-thousandth part of a millimetre, and represented by the Greek letter μ. So we say, therefore, that the limits of microscopic *resolution* are about .25 μ, which is actually about half the mean wave-length of light. By using light of shorter wave-length, or by using oblique light, we can reduce this figure somewhat, but this need not detain us at the moment.

It will be noted that this is our limit for resolving or separating two lines this distance apart, but isolated particles of considerably less size can be made visible as such, and this was distinctly recognised by Abbe, who states: "Such objects can be seen no matter how small they may be; it is only a question of the contrast of the light effect, good definition of the objective, and sensitiveness of the retina." Thus, minute granules, cocci, etc., may be visible quite distinctly in a field of view, where it would be found impossible to separate two lying close together, and the most careful adjustment of light or straining of the vision fails to show us their actual structure.

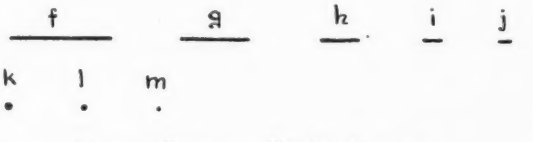
As a matter of fact, we may go a step further and by suitable illumination may make visible objects that are really so small that the microscope used in the ordinary way could not show them at all. We can light them up as luminous bodies like the stars, showing no attempt at structure, but appearing merely as bright discs. It is particles of this size that are now known as "ultra-microscopic particles," and it is to the work of Siedentopf and Zsigmondy that we are indebted for an entirely new branch of microscopic investigation.

The principle is simple enough, and to explain it the authors have used the homely illustration of a crowd of motes of dust dancing in a beam of sunlight which enters a dark room through a crack in the shutter, the observer standing at one side so that the shaft of light does not enter his eye directly. Each mote will be lit up as a disc of light clearly visible, whereas the motes themselves are much too small to be seen in the ordinary way by the unaided eye. So in the ultra-microscope designed by Siedentopf, a very narrow beam of light, collected by means of a slit and lens system from the sun or a powerful electric arc lamp, is passed into a fluid at right angles to the optic axis of the



A to E = linear magnification of 10,000.

A	Human blood corpuscle	= 7·5 μ
B	Anthrax bacillus	= 4-15 μ
C	Cocci	= ·5-2 μ
D	Particles from settled gold suspensions ..	= 075-·2 μ
E	Particles from colloidal gold solutions ..	= ·006-·015 μ



f to m = linear magnification of 1,000,000.

f	Gold particle ..	= 15 $\mu\mu$	j	Gold particle ..	= 1·7 $\mu\mu$
g	,, ,, ..	= 10 $\mu\mu$	k	Chloroform molecule	= ·8 $\mu\mu$
h	,, ,, .	= 6 $\mu\mu$	l	Alcohol ,,	= ·5 $\mu\mu$
i	,, ,, ..	= 3 $\mu\mu$	m	Hydrogen ,,	= ·1 $\mu\mu$

microscope and any particles suspended in this fluid will become visible as illuminated discs. But it must be again repeated that they will show no structure, they will merely be structureless discs of light.

If .25 μ is the limit of resolution in the microscope, what is the limit, therefore, of mere *visibility?* Theoretically there is no limit other than the impossibility of getting light strong enough to make the smallest particles of all evident, but this limitation is, unfortunately, a real one. Zsigmondy states that as a result of his experiments with minute gold particles he has found that particles with a linear dimension of 15 $\mu\mu$ ($\mu\mu$ = one-thousandth of a micron—see above) lie at the limit of visibility with the electric arc light, and that smaller particles can be made evident only by using sunlight. The smallest which can as yet be rendered visible are about 5 $\mu\mu$, and these can only be seen with the brightest sunlight on very clear days and with efficient means of cutting off all extraneous light. Moreover, as the refractive index of metallic gold differs greatly from that of water, particles of other substances which are less than 15 $\mu\mu$ cannot be made visible with the arc light under present conditions, except those of a few metals.

and, perhaps, those of fluorescent dye-stuffs. This disposes, as Zsigmondy himself states, of many divergent statements as to the limits of visibility of ultra-microscopic particles, which may easily lead to an exaggerated idea of the method described by himself and Siedentopf.

When this method was first announced hopes were raised that new light would be shed upon the physical nature of colloidal solutions, and even of crystallographic solutions, and that possibly even the molecule might be made visible, but the following measurements will show how far we are from this result.

Zsigmondy's investigations have been mainly directed towards the examination of gold particles in colloidal solutions, selected because of their convenience in many ways. Some idea of his results may be gained by observing that whereas an ordinary red-blood corpuscle (a common standard of comparative measurement) has a diameter of 7.5 μ, an anthrax bacillus a length of 4-15 μ with a width of 1 μ, and cocci a diameter of .5-1 μ, particles in colloidal gold solutions may be as small as .0017-.015 μ (1.7-15 $\mu\mu$). Compared with these measurements, minute though they are, we have to face the fact that the chloroform molecule has been estimated at .8 $\mu\mu$, the alcohol molecule at .5 $\mu\mu$, and the hydrogen molecule at .1 $\mu\mu$.

The accompanying figures (adapted from Zsigmondy's "Colloids and the Ultra-microscope") may make this point clearer. They represent linear dimensions, A to E having a linear magnification of 10,000, whilst f to m have a linear magnification of 1,000,000.

As we have already stated that the smallest particles which are visible under the most favourable conditions of sunlight are about 6 $\mu\mu$, it may, as Siedentopf himself states, be taken for granted that with no artificial illumination, however intense, will it be possible to discern with the human eye dimensions so small as those attributed to medium-sized molecules (about .6 $\mu\mu$). A reference to the accompanying figure will show, therefore, that the estimated measurements of such molecules as those of chloroform, alcohol, and hydrogen, leave them beyond our reach.

With regard to other directions of investigation, however, Raehlmann has demonstrated the individual particles in glycogen solutions, and has followed in the ultra-microscope their disappearance upon the addition of diastase. Romer has made analogous investigations concerning solutions of true proteins, and the action of these particles towards specific ferments appears to prove that they are the essential constituents of glycogen and protein solutions. Romer has also identified albumen particles in the urine of nephritic patients. In all these cases, however, relatively large particles are being dealt with, as the electric arc light gives sufficient illumination to make them visible. An interesting investigation is that of Biltz and Gahl, who investigated the decomposition of thiosulphuric acid, which slowly becomes turbid when acidified. This is either a case of a crystalloid solution in a state of supersaturation, which is in a short time broken up into a suspension, or an imperceptible colloidal solution is first formed, the particles of which will grow until they can be seen with the ultra microscope. Biltz and Gahl have watched the process and shown that it is discontinuous, the field of view remaining for a time unchanged, then a sudden turbidity appearing and increasing, with the formation of definitely visible ultra-microscopic particles. Investigations by other workers have shown that glycogen solutions are filled with ultra-microscopic particles having an oscillatory motion.

All these results have been set forth in much detail by Zsigmondy, whose book on "Colloids and the Ultra-microscope," already alluded to, contains much painstaking original work, and a full account of his apparatus and methods. He has been able to show the presence of ultra-microscopic particles as an essential constituent of colloidal solutions, to measure the size in many cases, to show that the particles may be as coarse as 60-80 $\mu\mu$, or so fine as to be hardly distinguished from many crystalloid solutions, and that numerous intermediaries exist. Moreover, he has shown that the smaller particles are in constant and very "active oscillatory and translatory motion," differing markedly from the irregular oscillation of Brownian movement. Further points elucidated are that in the case of metal subdivisions (*e.g.*, gold in ruby glass) there is no relation between the size of the particles and their colour. A point of interest to bacteriologists is that protected gold particles of 30 $\mu\mu$ and over easily pass through the pores of Chamberland filters, and those of Maassen and Pukall. In addition, Zsigmondy's researches throw not a little light upon the relations existing between suspensions, colloidal, and crystallographic solutions.

Influence of Cold on Scales of Lepidoptera.

The Journal of the Royal Microscopical Society (1909, p. 569) summarises some interesting experiments by P. Kosminsky, who has subjected pupæ of *Vanessa io*, *Vanessa antiopa*, and *Limantria dispar*, to moist surroundings, and found that this had very little effect on coloration, marking, or scales. When, however, he subjected the same and other forms (*Malacosoma neustria* and *Arctia villica*) to moderate cold as well as moisture, he found that the scales became narrower and smaller. In cases where the temperature was not moderately low, but below zero, enlarged and broadened scales sometimes resulted, and there were interesting changes in the colouring and in the antennæ of the female of *Limantria dispar*, which approached the male in appearance.

Parasitic Rotifer in Rhizopod.

In "Mikrokosmos," a new addition to the ranks of microscopical publications in Germany, E. Penard describes and illustrates a rotifer, *Proales latrunculus* sp. n., which lives parasitically within and on the Heliozoon, *Acanthocystis turfacea*. This small rotifer, which is only about 90 μ in size, allows itself to be ingulfed in the usual Rhizopod fashion by its unsuspecting host, but no sooner has the envelope closed upon the Rotifer than it expands its ciliary wreath and proceeds to eat up everything it can find in the larder, then it attacks the protoplasmic walls and feeds on these. A terrible struggle now goes on between the host and its prey, which usually lasts about six hours and nearly always ends with the death of the Rhizopod. When the *Proales* has fed sufficiently and *Acanthocystis* has given up the struggle, it begins to lay eggs, one to three in number, and then it seems to consider it is time to get out of its prison, for it proceeds to push, bite, and hammer at a selected spot until the thick wall and plates give way and the little Rotifer can escape into the open. The eggs mature in about 24 hours and the young escape through the opening made by the parent, in order to repeat this remarkable life-history. In the summer of 1904 Dr. Penard found nearly half of all the *Acanthocystis turfacea* afflicted with this parasite, a regular plague for these Rhizopods.—(J.R.M.S., 1909, p. 579.)

Photography by Reflection Under Contact.

The Journal of the Royal Microscopical Society (1909, p. 647) gives the following summary of a new

process described by E. E. Fournier d'Albe in the Scientific Proceedings of the Royal Dublin Society (xii., 1909, pp. 97-100), which is likely to interest photographers of all kinds. In the usual methods of contact photography a copy is taken of the original or negative by allowing light to pass through the latter on to a sensitive surface; the resulting picture is due to differences in opacity in the various points of the original or negative. But the author's new process consists in transmitting the light in the reverse direction, and in producing a picture, not by differences of opacity, but by differences of reflecting power in the original. The obvious objection to such a method is that the sensitive film, being exposed to a uniform incident illumination coming through the back of the plate, will be uniformly fogged, and the resulting positive will be marred by a brightness which invades and obliterates all the dark portions. If this difficulty can be overcome we obtain a method of copying any flat picture or design without a camera, and we avoid the difficulties of distortion, curvature of field, chromatic and spherical aberration, and so on. When the original to be copied has no half-tones it is possible, by suitable exposure and development, to eliminate the fog entirely. The general principle is to employ exposures and developers which, in ordinary photography, "suppress the detail in the shadows," or, in other words, confine the developed image to those portions which have received the maximum illumination. The author gives details and illustrations of the method.

But the fog may also be eliminated by reduction and subsequent intensification. Howard Farmer's reducer (potassium ferrocyanide and hyposulphite of soda) dissolves away the fog more than the full tone, if sufficiently concentrated. The negative is intensified with mercuric chloride and silver nitrate. The best results are obtained with slow plates of the "photo-mechanical" class, and the developer used was the following:

Solution No. 1.	Hydroquinone ...	gr. 80
	Pot. metabisulphite...	gr. 120
	Pot. bromide ...	gr. 10
	Water, etc. ...	1 oz.
Solution No. 2.	Caustic potash ...	gr. 200
	Water, etc. ...	10 oz.

Equal parts of both solutions are mixed.

The best fixing agent is potassium cyanide, on account of its solving action on thinly deposited silver. The author, however, used the ordinary bath.

Excellent paper negatives were obtained with rapid bromide papers, and also with gas-light papers. On printing positives from them in the ordinary way the grain of the paper negative disappears, as it is automatically compensated by the grain within the paper which gave rise to it. Printing-out papers also give negatives which can be used for printing positives on bromide paper without previous toning and fixing, but the exposure has to be very long.

In applying the process to black or white originals, certain advantages are gained over the ordinary methods with the camera:—(1) The reproduction is of exact size with the original. (2) The sharpness of definition is only limited by the size of the silver grain in the plate. (3) All differences in the angle of reflection of light by the original are avoided, all the effective light emerging at right angles to the surface.

Observing Refractive Indices Microscopically.

An Italian worker has described a simple method by which the microscope can be used to take refractive indices with an accuracy quite sufficient for most mineralogical and petrological purposes. A small cylindrical cell is affixed to a slide, and at the bottom is fixed a small glass prism. A ray of light passing through this will, of course, be refracted, and the amount of refraction will correspond to the refractive index of the liquid in the cell. This can be measured—in arbitrary terms—with the cross-threads of an eye-piece micrometer. A curve for comparison is constructed by filling the cell with a series of liquids whose refractive index is known beforehand, and adding a cover-slip, and by reference to this curve the refractive index of an unknown liquid examined under identical conditions can be approximately estimated.

Henri van Heurck.

An obituary notice of the late Professor H. van Heurck, written by J. Chalon, gives some further particulars which may interest those who read the obituary notice published last month. M. Chalon gives an account of Professor van Heurck's collection of drugs, microscopes, diatoms, algæ, phanerogams, physical instruments, etc. One of the unique treasures is Möller's famous type-slide containing 4,026 species of diatoms arranged in perfect order within a square of 6 mm. diameter. It cost £40, and it occupied Möller forty full days to place the diatoms in position alone! From 1864-99 van Heurck was Professor of Chemistry at the School of Industry at Antwerp. Whilst he was in charge of his father's paint and varnish factory he invented certain varnishes and lacquers which have stood the test of time exceedingly well. It was he who prepared and patented the dentifrice odol. In 1876 he was appointed professor for life at the Antwerp Botanic Gardens. The proofs of his last work—on the Diatoms collected by the "Belgica" Antarctic Expedition—he finished correcting on his death-bed.

Royal Microscopical Society.

October 20.—Mr. Wynne E. Baxter described the slide of *Aulacodiscus superbus*, presented by Mr. J. T. N. Thomas, as a very valuable present, this diatom being extremely rare and only found four or five times. In 1860 Dr. Greville was giving his papers on the Diatomaceæ which had been recently found, and the bulk of the discoveries came from the same place as this *Aulacodiscus*—the Island of Barbadoes, which contained an unusually large number of chalky-looking calcareous and siliceous deposits of deep-sea origin. *Aulacodiscus superbus* was one of the rare diatoms of the genus, all species of which were either marine or were found in marine deposits; they were all circular, and all nearly flat, with costæ, moniliform rays, or well marked sulci connecting the processes, which usually project; the peculiarity of this one being that it has a reticulation something like that seen in *Triceratium grande*. The only published illustration of it was by Mr. Kitton, printed in 1857, when it was described as being covered with a sort of mulberry elevation, and a comparison of this drawing with the diatom would show the great improvement which had taken place in objectives since that time.

Mr. Earland called attention to a slide of *Nubecularia lucifuga*, from the Bognor shore sand, amongst some slides of Foraminifera from the collection of the late Mr. Wm. Kitchen Parker, presented by Mr. Ernest Heath. This slide was apparently more than fifty years old, while the species in question was not recorded in Britain until 1879. Had Parker noticed his specimen the record would have been anticipated by many years.

Mr. C. Beck described a lamp presented by Mr.

Gordon, which consisted of three glass rods whose ends were illuminated by a central electric lamp. One end of each glass rod was clear and the other ground, so that a perfectly homogeneous area of light surface was obtained. By this means the light produced did not give an image of the filament in the field of the microscope when high powers and a focussed condenser were used. The intensity of the light could also be easily regulated by varying the distance of the glass rods from the lamp by moving the former in or out of its brass tube, and this was done without disturbing any other arrangement. This means of varying the amount of light was very useful when colour screens were used. The present lamp was designed for use with three microscopes and contained, therefore, three rods. Subsequent discussion showed that the principle had been utilised about twenty-five or thirty years earlier, but had apparently fallen into disuse.

Dr. Hebb read a paper by Mr. F. Chapman "On the Microscopical Structure of an Inoceramous Limestone in the Queensland Cretaceous Rocks," illustrated with plates.

Mr. C. F. Rousselet called attention to a slide of a rare spherical Rotifer, *Trochosphæra æquatorialis*, which had never been exhibited anywhere before. It came from Brisbane, Queensland, where it was first found in 1889 by Surgeon Gunson Thorpe, but had disappeared for a long time. This species, originally discovered in the Philippine Islands about fifty years ago by Professor Semper, is of peculiar interest, as it closely resembles in outward form the *Trochosphæra* larvæ of the marine worm *Polygordius*, and to this resemblance has been in great part due the theory that the Rotifera are derived from worms. The discovery of *Pedalion* has later thrown doubt on this derivation. Mr. Wesché said that when he visited Brisbane he had, at Mr. Rousselet's request, visited this particular pond, but found it had been washed out by a tidal wave and its contents destroyed. He thought the resemblance of this rotifer to a worm bore out Huxley's idea that Rotifers were permanent forms of larvæ.

Quekett Microscopical Club.

October 26.—A paper on "The Life-History of the Tachinid Fly, *Phorocera serriventris*, Rondani," communicated by Mr. W. Wesché, F.R.M.S., was read. The author had established the fact that this fly is viviporous and in one preparation of a female had counted the unusually large number of ninety-eight jaws of larvæ. The ovipositor is used by the female to make an aperture in the skin of certain caterpillars (six species were mentioned) into which living larvæ were introduced. Six species of flies having the viviporous habit were described. These were *Oliviera lateralis*, F., *Plagia trepida*, Mg., *Phorocera serriventris*, Rondani, *Phora ruficornis*, Mg., *Myioba fenestrata*, Mg., and *Siphona geniculata*, Deg. The last two species are here first so described. Mr. Wesché also contributed a note on "A Quick Method of Preparing and Staining Pollen." Mr. J. P. Wright sent a short note relating to some as yet unidentified beetles found in bales of Turkish tobacco-leaf. Mr. A. C. Banfield gave an interesting lecture on "Low Power Photomicrography, with especial reference to its Application to Stereoscopy." After a short account of the principles of stereoscopic vision and a recommendation for the use of a lens separation of 62 mm., the average interocular distance, in place of the usual 80 mm., which gives exaggerated results, the lecturer described his own methods. He used the standard English stereoscopic size $6\frac{3}{4} \times 3\frac{1}{4}$ inches. The ground-glass was ruled with two parallel lines 62 mm. apart. Employing any objective giving the required degree of magnification the object is moved on the stage till one of the lines cuts the image centrally. An exposure is made. The image is then transferred to the other line and a second exposure obtained, the two giving a truly stereoscopic pair. Incident lighting was preferred.

Mr. James Murray exhibited some preparations of Rotifers obtained near Ross Island by the "Nimrod" during Shackleton's Antarctic Expedition.

Notes and Queries.

New Catalogues.—Mr. Thos. Thorp, of 18, Chapel Street, Guildford, and St. Martin's Lane, W.C., sends me a catalogue of second-hand books on zoology, botany, astronomy, and physics.

Messrs. Ernst Leitz send me new editions of their catalogues of microscopes and microscope accessories. The microscopes include the improved stands fitted with rigid limb, and new fine adjustment, and the accessories include a new aplanatic and achromatic condenser of N.A. 1.4, with an aplanatic cone of but slightly less, and with a focal length of about $\frac{1}{3}$ of an inch. There is also a simplified apparatus after Siedentopf and Zsigmondy for the demonstration of ultra-microscopic particles, and there are new forms of vertical illuminator, and a new automatic mechanical stage.

Microscope Chart.—The Bausch and Lomb Optical Co. have been good enough to send me a new microscope chart, an enlargement of one of the blocks in their catalogue, showing an outline of a complete microscope, with ocular, objective, and condenser, and tracing the path of the rays up to the formation of the final visual image. The chart is 5 ft. 9 ins. by 3 ft. 9 ins., and is mounted on linen, varnished, and fitted with rollers. For those who, like myself, lecture on microscopical optics, it saves no little black-board drawing, and Messrs. Bausch and Lomb generously offer to give one of these charts free of charge to any college or medical institution where it can be advantageously used, but as they are naturally expensive they can only send them where they can be made real use of.

New Catalogues.—From The Cambridge Scientific Instrument Co., I have received a new list of their well-known Rocking Microtomes. These microtomes are, as is well known, adapted to cut serial sections of moderate size, in paraffin only, but they are unsurpassed in this respect by any other instrument, whether for simplicity, regularity, ease of adjustment, or cheapness, and they are accordingly in use in nearly all scientific laboratories in this country. The list also includes particulars of embedding baths fitted with copper pans, tubes, phials, and gas regulator, and of a new dissecting-lens holder with mechanical adjustment of an improved type.

Mr. Chas. Baker sends his quarterly list of second-hand microscopes, objectives, accessories, and other scientific instruments.

Mr. H. W. H. Darlaston, of Birmingham, has issued a catalogue of microscopical slides containing anatomical and pathological sections, botanical, entomological, and general zoological preparations, all uniformly priced at sixpence each, and a list of photo-micrographic lantern slides. Mr. Darlaston also mounts special slides to order, or from customers' own material at a very moderate cost.

The Bausch and Lomb Optical Co. send a list of new appliances made by them for the projection of opaque objects upon the screen by means of reflected light, a revised list of new and improved microscopes, and a copy of the "Prism" (Vol. II., No. 12), a little booklet of 16 pages published by the same firm, and which deals with the projection apparatus just mentioned.

[Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Redcourt," Adams Road, Cambridge. Correspondents are requested not to send specimens to be named.]

XUM

The Face of the Sky for December.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 7.45 and sets at 3.53; on the 31st he rises at 8.8 and sets at 3.58. The equation of time on the 25th at noon is only 1 second, and for ordinary purposes is negligible. Winter commences on the 22nd, when the Sun enters the sign of Capricorn at 11.20 a.m.; this is the shortest day, the Sun rising at 8.6 and setting at 3.51. Sunspots and faculæ may usually be observed on the solar disc; lately they have been unusually numerous, producing an elevation on the downward trace of the sunspot cycle. A partial eclipse of the Sun occurs on the 12th, visible only at the Antipodes and in the Antarctic Ocean. The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given below:—

Date.	Axis inclined from N. point.	Centre of Disc N. or S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Dec. 2 ..	15° 47′E	0° 37′N	107° 17′
,, 7 ..	13° 45′E	0° 2′S	41° 24′
,, 12 ..	11° 35′E	0° 40′S	335° 31′
,, 17 ..	9° 19′E	1° 19′S	269° 39′
,, 22 ..	6° 58′E	1° 56′S	203° 47′
,, 27 ..	4° 34′E	2° 33′S	137° 55′

THE MOON:—

Date.	Phases.	H. M.
Dec. 4..	☾ Last Quarter	4 12 p.m.
,, 12..	● New Moon	7 59 p.m.
,, 20..	☽ First Quarter	2 18 a.m.
,, 26..	○ Full Moon	9 30 p.m.

OCCULTATIONS.—The following table gives particulars of the principal occultations visible at Greenwich:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. point. E.	Mean Time.	Angle from N. point. E.
			P.M.		P.M.	
Dec. 22	ξ Arietis ..	5·5	6.45	95°	7 41	201°
,, 24	ω^2 Tauri ..	4·6	6.10	25°	6.58	288°
,, 24	B D. + 20° 751	5·9	9. 5	71°	10 18	248°
			A.M.		A.M.	
,, 27	ϵ Geminorum .	3·2	5.13	102°	6. 9	271°
,, 28	κ Geminorum .	3·7	5. 2	105°	6. 2	283°

THE PLANETS.—Mercury (Dec. 1, R.A. 16h 23m; Dec. S. 22° 18′. Dec. 31, R.A. 19h 49m; Dec. S. 23° 8′) is in superior conjunction with the Sun on the 3rd, and thus is unobservable. Towards the end of the month the planet becomes an evening star in Sagittarius, and sets at 4.53 p.m. on the 28th.

Venus (Dec. 1, R.A. 19h 54m; Dec. S. 23° 44′. Dec. 31, R.A. 21h 40m; Dec. S. 14° 16′) is a very conspicuous object in the South-West portion of the sky shortly after sunset. The planet is at greatest Easterly elongation of 47° 18′ on the 2nd, and sets about 7 p.m. at the beginning of the month, and at 7.52 p.m. on the 31st. The elongation is not very favourable on account of the large South declination, but as the planet approaches greatest brilliancy the declination diminishes and the planet sets correspondingly later. As seen in the telescope the disc appears at half-moon phase on the 2nd, and gradually becomes more crescent towards the end of the month; at the same time the planet increases in brightness. The coincidence of Venus as a bright evening star with Christmas frequently results in the planet receiving the appellation of "the Star of Bethlehem." On the evening of the 16th the Moon appears near the planet.

Mars (Dec. 1, R.A. 0h 14m; Dec. N. 1° 3′. Dec. 31, R.A. 1h 4m; Dec. N. 7° 20′) is visible all the evening, being on the meridian about 7 p.m. and setting on the 31st at 1.9 a.m. On account of increased distance from the Earth, the planet is rapidly diminishing in brightness, the apparent diameter being now only 10″, as compared with 24″ at opposition. The Southern hemisphere is inclined towards the Earth, and the South Polar Cap is favourably placed for observation, but the Cap has now dwindled to very small dimensions, having apparently been dissolved by the Martian summer. Mars is a very difficult object in small telescopes, and at the best little more than dusky markings can be discerned. The Moon appears 5° South of the planet on the 20th, and Saturn appears 3° South on the 31st.

Jupiter (Dec. 1, R.A. 12h 37m; Dec. S. 2° 41′. Dec. 31, R.A. 12h 51m; Dec. S. 4° 1′) is visible in the mornings, rising at 1 a.m. on the 23rd.

Saturn (Dec. 1, R.A. 1h 6m; Dec. N. 4° 5′. Dec. 31, R.A. 1h 5m; Dec. N. 4° 9′) is very favourably placed for observation, being due South on the 1st at 8.25 p.m. and at 6.27 p.m. on the 31st. The planet is situated to the South-East of the square of Pegasus and to the East of Mars, and is readily distinguished by his brightness and leaden lustre, its rays being devoid of the sparkling qualities of Venus or Jupiter. Saturn forms one of the easiest and at the same time most interesting of telescopic objects, since the rings, polar compression, and dusky belts on the disc may be observed on nights fatal to objects like Mars. The diameter of the ball is 17″ whilst the diameters of the outer major and minor axes of the ring are 43″ and 8″ respectively. The Southern surface of the ring is presented to us at an angle of 10° to our line of vision, thus the ring appears open. The planet is in conjunction with Mars on the 31st, Mars being 3° 11′ N.

Uranus (Dec. 15, R.A. 19h 25m; Dec. S. 22° 28′) is approaching conjunction with the Sun, and hence is practically unobservable as he sets about 6 p.m. near the middle of the month.

Neptune (Dec. 15, R.A. 7h 20m; Dec. N. 21° 27′) rises about 5.50 p.m. near the middle of the month, and is due South about 1.40 a.m. The planet is situated in Gemini, about one degree South-East of the star δ Geminorum.

METEORS.—The principal shower of meteors during the month is the Geminids, Dec. 10th to 12th; the radiant is near Castor, in R.A. VII.h 12m, Dec. + 33°. The meteors are short and quick, and difficult to record accurately.

Minima of Algol may be observed on the 13th at 9.27 p.m., and on the 16th at 6.16 p.m.

TELESCOPIC OBJECTS:—

DOUBLE STARS.—1 Pegasi 21h 17·5m, N. 19° 20′, mags. 4·5, 8·6; separation 36″·2.

π Andromedæ 0h 31·5m, N. 33° 11′, mags. 4·0, 8·0; separation 36″·3.

α Piscium 1h 56·9m, N. 2° 17′, mags. 3·7, 4·7; separation 3″·6.

ι Trianguli 2h 6·6m, N. 29° 50′, mags. 5, 6·4; separation 3″·5.

CLUSTERS.—(♅ VI. 33, 34.) The Perseus clusters visible to the naked eye and situated about midway between γ Persei and δ Cassiopeiæ. These magnificent clusters are described by Smyth as "affording together one of the most brilliant telescopic objects in the heavens."

(M 34.) A mass of small stars about the 8th magnitude; not very compact. The cluster is just perceptible to the naked eye about 5° North-West of Algol.

XUM